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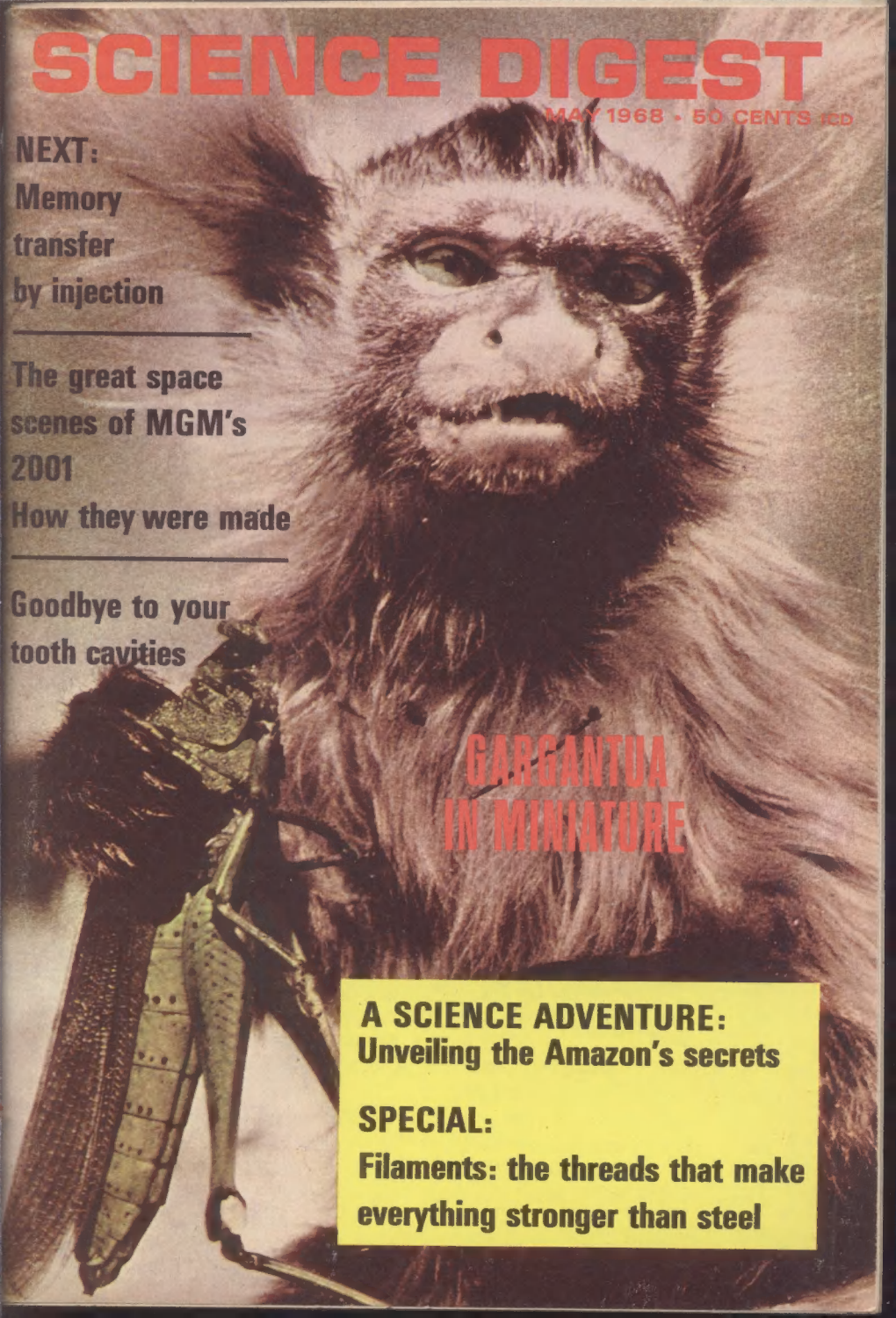

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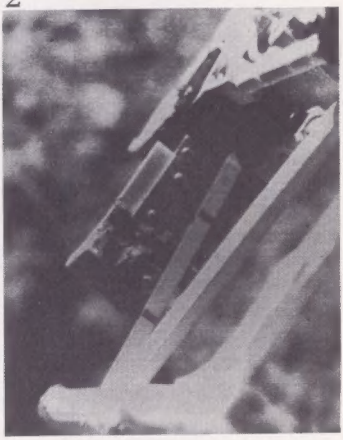

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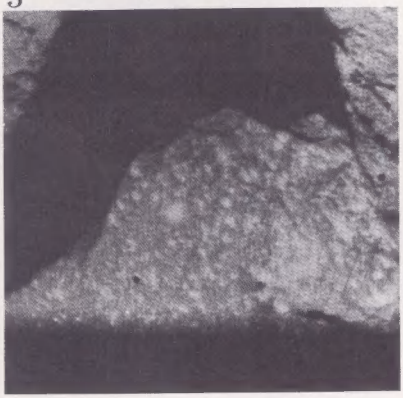

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Surveyor digs in

THE National Aeronautics and Space Administration recently released photographs taken by Surveyor VII from its landing spot north of the crater Tycho on the moon's surface.

1. Mosaic of pictures shows Surveyor's surface sampler digging a trench. Elsewhere on the surface can be seen other results of sampler operations — trenches, bearing strength tests and disturbed rocks.

2. A rock fragment and a small amount of loose lunar material adhering to the back of the surface sampler's scoop door. The rock fragment appears to have been retained by two small horseshoe magnets imbedded in the flat bottom of the scoop door.

3. Part of a dense, angular, spotted rock about eight to 12 inches across near landing site.

4. Rectangular block about 4 inches across located about 30 feet from Surveyor.

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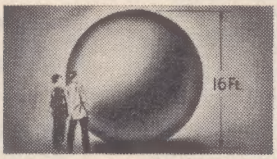

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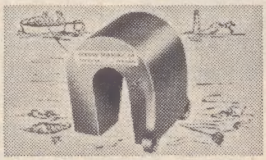

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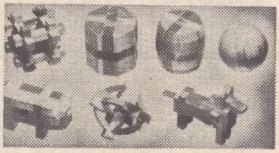

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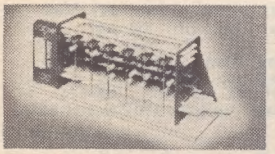

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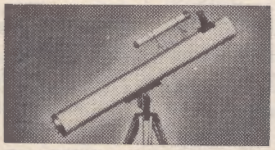

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As more and more success is reported on vital organ transplants, a lot of scientists are taking a longer look at what they are creating. Recently, a letter from a friend in England reports on reactions in Europe to some of the more hair-raising proposals:

In Russia, for instance, Dr. Vladimir Demikhov—a top surgeon—suggests that organs from newly dead could be connected to large blood vessels (the thigh) of "human vegetables," whose brains have been destroyed by accident or disease, and thus preserved in a bank of "healthy organs for patients of all ages who need them."

THIS MONTH

Britain's own auto club has a running campaign persuading motorists to sign away their bodies for spare part surgery.

But Sir George Pickering, Regius Professor of Medicine at Oxford, blows the whistle on such talk. The technique has vast potentials for ill, he believes. Old people are living longer already, he points out, increasing the proportion of senile people among us. Keep it up and we'll populate ourselves out of existence. "Death is as important and useful as life," says Sir George. "It offers a brighter future to the next generation . . . When my time comes to die, I hope I'll be allowed to do so."

We agree with Sir George.—*RFD*

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Editorial and general offices:
575 Lexington Ave., New York, N.Y. 10022

Subscription offices:
250 West 55th Street, New York, N.Y. 10019

Advertising offices:
GERARD PROVENCE, Advertising Director
575 Lexington Ave., New York, N.Y. 10022
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SCIENCE DIGEST is published monthly by The Hearst Corporation, 959 Eighth Avenue, New York, N.Y., 10019. RICHARD E. BERLIN, *President;* GEORGE HEARST, *V-Pres.;* RICHARD E. DEEMS, *President of Magazines;* JOHN R. MILLER, *Executive V-Pres., Magazines;* WILLIAM S. CAMPBELL, *V-Pres., Magazines;* ALBERT A. RACHOI, *V-Pres. and Director of Circulation;* RAYMOND J. PETERSEN, *Senior V-Pres. of Magazines;* FRANK MASSI, *Treas.;* HARVEY L. LIPTON, *Sec.*

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Up close he looks like a monster. But he is really quite shy and very small. He is one of the marmoset clan, the world's smallest, least known and most engaging monkeys. Think he would make a grand pet? Read the story on page 28 and think again!
Keystone Photo

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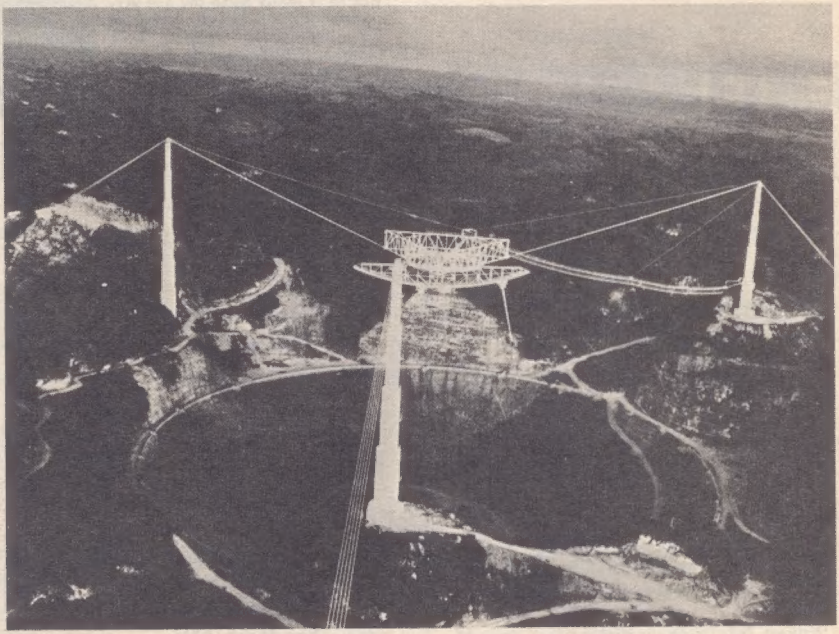

Bulletins at press time

IS ANYONE OUT THERE? Radio astronomers in the U.S. and Britain are picking up signals from space which they describe as "very spooky". The signals are powerful, rapid, regular and have other characteristics which might suggest an artificial origin. The strange space signals were detected by British astronomers and first reported in February. More recently, further investigations have been made with the giant bowl-antenna at Arecibo, Puerto Rico (above). Astronomers, even those fully convinced of the existence of extraterrestrial intelligence, believe that these signals will probably turn out to be from natural sources. But they are keeping their options open. Most of them would probably agree with the science fiction writer and science speculator Arthur C. Clarke, who told Science Digest, "If I had a dollar to bet on those signals coming from other civilizations I'd probably put down a quarter of it."

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WSD8E1

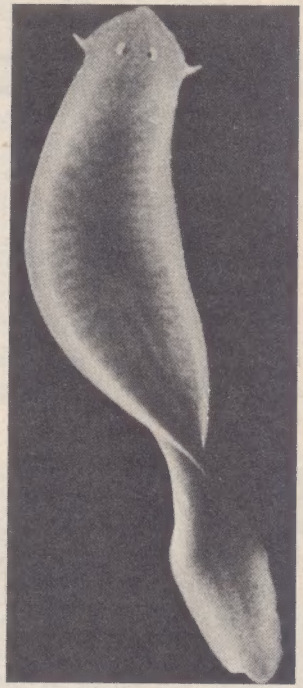
DISASTER FOR CALIFORNIA? Tension is building up along the San Andreas Fault in the vicinity of San Francisco, and some geologists think a major earthquake may be on the way. Measurements made on the fault just south of San Francisco show that the distortion of the landscape has increased sharply in the past year. Dr. Peter Franken, a U. of Michigan physicist, said the strain level along the fault probably exceeded that prior to the disastrous 1906 quake. He warned of a catastrophe that "quite possibly" could severely damage San Francisco and Los Angeles. Many scientists discounted the warning until they discovered the extent of the earth changes. Now they believe there is reason for serious concern.

BROKEN CHROMOSOMES. Medicine is becoming increasingly alarmed about the genetic effects of new drugs The Wall Street Journal reports. The concern began with the discovery that LSD users have broken chromosomes in their white blood cells. But now the list of substances suspected of causing chromosome breaks has been expanded to include some widely used antibiotics, tranquilizers, amphetamines and fungicides, as well as caffeine. No one is sure that chromosome breaks actually cause genetic damage, but the harm may not show up for several generations, doctors say.

SUPERSONIC JET THREAT. A leading atmospheric scientist has warned that supersonic jets may adversely affect the world's weather and envelop the earth in a "global gloom" of haze. Dr. Vincent J. Schaefer points out that the SSTs now being developed will dump their exhaust into a region of the stratosphere with much horizontal air movement, but little vertical motion.

FASTER VIRUS IDENTIFICATION. A new technique makes it possible to identify individual viruses by analyzing the chemicals arising from their interaction with the body cells. It will cut identification time down to a few hours. Previously, identifying viruses took days of testing.

Can memory be transferred by injection?



If an untrained flatworm eats a trained flatworm, it seems to be able to 'digest' some of the training. The implications are heretical to orthodox psychologists, so the creature is involved in a scientific holy war.

by Bruce Frisch

SCIENTISTS at Brookhaven National Laboratory were playing a losing game of wits with inch-long pond flatworms. The planarians were supposed to stay in an earthenware dish filled with water and get a periodic electric shock. Instead, they climbed out of the water and perched on the rim.

"The planarians took two days to learn how to avoid shock," says Dr. William Corning. "It took us two weeks and a lot of money to figure out how to keep them from avoiding it."

Dr. Corning, a psychologist now at Fordham University, does not mind playing the fool, if it makes the planarian look good. His story is another shot in the fight against scientists who will not give a hearing to memory or learning transfer, the passing of some of the learning of animal A to animal B by giving animal B material from the brain of animal A.

Psychologists have been losing their heads over the argument, which has reached the pitch of a religious war. The minority, amounting to 10 percent of psychologists, one of them estimates, are cast by

the majority as wanderers from the true religion of scientific psychology in pursuit of a vision created more by what they would like to believe than facts. Transferrers see themselves as uninhibited by fears of shaking up old-time doctrine, if that is where facts may lead.

Can planarians learn?

Memory transfer was discovered in experiments with planarians. Now some critics are saying planarians cannot learn in the first place, so how could their learning be transferred?

Actually, asserts Dr. Corning, "There is little doubt they can learn." It may be the lowest animal capable of doing so, however. In 1953, Robert Thomson and James McConnell, graduate students in psychology at the University of Texas, started trying to teach the planarian, because it was the lowest animal with synapses (the connections between nerve cells) like higher animals and had at its head end a concentration of nerve cells called a ganglion that could be thought of as a primitive brain. Thomson and McConnell wanted to explore then-new versions of the theory that a memory is a circuit of neurons set up by easy conduction across certain synapses.

They put planarians in a water-filled trough and switched on a bright light for three seconds accompanied by an electric shock for the last second. During shock, planarians tensed their muscles, contracting their bodies. Soon they contracted in response to the light alone.

In 1956, Dr. McConnell went to the University of Michigan, where he is now a professor at the Mental Health Research Institute. There he interested others in helping him do experiments he and Thomson had thought up. They trained planarians, cut them in half and waited a few weeks for the pieces to regenerate into whole worms. Then they tested the worms' reaction to light. The original heads with their new tails remembered, as Dr. McConnell had expected. But the old tails with new heads also remembered. This Dr. McConnell had not expected. It suggested to the group that a memory was not stored just in the planarian brain, but was a biochemical change that took place throughout its whole body.

Old, new heads remembered

To test this general idea they cut more trained planarians in half, threw away tails and waited for heads to grow new tails. Then they cut off the new tails and let them grow new heads. They ended up with all-new animals, which still remembered.

At this time Dr. McConnell heard of the theory of Dr. Holger Hydén, a neurobiologist at the University of Göteborg, Sweden, who suggested memories might be molecules of ribonucleic acid (RNA). Long molecules of deoxyribonucleic

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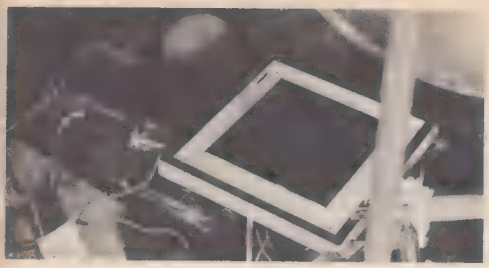

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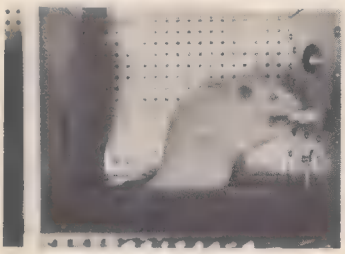

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1. A classical conditioning trough for planarians. Electrodes on the sides transmit electric shock. 2. U. of Michigan's Dr. James V. McConnell, the man who started it all, trains a planarian in a T-maze. 3. A white rat, traditional animal in experimental psychology studies, presses a lever to get reward of milk. 4. After pressing lever, rat has been trained to turn to hole at back of cage to find milk. 5. Dr. McConnell and assistant, Tsuyoshi Shigehisa, inject rat with RNA from trained rat. 6. Dr. George Ungar of Baylor University ran across memory transfer accidentally while studying morphine addiction in rats. He is now a believer.

acid (DNA) in the nucleus of the cell are coded to carry the complete plans for a whole animal. Portions are copied as molecules of RNA, which go out into the cell and carry out the plans by controlling the construction of proteins. Dr. Hydén thought outside experiences, as well as DNA, might code RNA inside neurons. Later he revised this idea.

Chewed up memory molecules

Before Dr. McConnell could test the RNA theory on his planarians, two scientists at the University of Rochester beat him to it. Dr. Corning and Dr. E. R. John cut trained planarians in half and let some regenerate in pond water and some in water dosed with ribonuclease, an enzyme that destroys RNA. Old heads with new tails could nevertheless remember. But old tails whose new heads grew in RNA-ase had their learning wiped out. One possible explanation was that RNA-ase had chewed up memory molecules.

Finally, the thought came to Dr. McConnell that if a memory was stored as a chemical in the planarian, he might be able to transfer the memory by transferring the chemical. The simplest way to transfer the chemical would be to let one planarian eat another. If starved, planarians turn cannibal, particularly if the victim is damaged. Their way of ingesting food whole would leave intact molecules of RNA.

Chopped, trained planarian was duly fed to hungry untrained worms who were then taught to react to a light. This group and three later ones learned exceptionally fast, as if they had eaten some training.

The report of the experiment in 1962 amazed scientists. Objections were not long in coming as many other workers found they could not repeat Dr. McConnell's experiments. Part of the trouble, believes Dr. Corning, is lack of experience in working with planarians. They have little quirks that have been learned slowly. For instance, slime in their dishes reduces their sensitivity to light. If they are kept in the dark, they become blind. One worker, noticing that the testing responses of a planarian had stopped abruptly, found the worm dividing. Testing a planarian at that time, says Dr. Corning, "would be equivalent to rushing into a delivery room and giving a woman an IQ test."

Planarians unconventional

Some of the heated opposition to the planarian work may come from an attachment to mice and rats conventionally used in behavioral testing, thinks Dr. Corning. Some men, he says, seem to think an animal test is worthless unless the animal has a tail.

Many psychologists, he continues, object to psychologists probing the physical workings of the brains; their proper job is studying only the output of the brain, behavior,

McConnell's success has been remarkable, but critics complain his experiments cannot be repeated.

they assert. Instead of limiting himself like that, argues Dr. Corning, "a psychologist should be the best-trained scientist, and he isn't."

It probably did not help Dr. McConnell with the conservatives when he started a flippant little sheet called *The Worm Runner's Digest*. The back half of the digest is made up of scientific humor. The front half contains reports of planarian research, some of which are later published in regular journals.

And there was always the possibility that Dr. McConnell was wrong. At any rate, Drs. Walter Moore and Henry Mahler, brain chemists at Indiana University, reported in a 1964 lecture, "The experiments with planarians at present are under something of a cloud."

The next year one of the men who had worked with Dr. McConnell, Dr. Allan Jacobson, cleared up one objection but stirred up several more after he went to UCLA as a psychology professor. He trained rats instead of planarians. A click was sounded, and shortly after a food pellet dropped into the rat's food cup. Eventually the rat learned to go to the food cup as soon as he heard the click. Trained rats were killed, the middle portions of their brains removed and the RNA extracted. The RNA was injected into the abdominal cavities of untrained rats. Each rat was then tested 25 times to see if it would go to the food tray when a click was sounded, but no food was given. Out of seven rats that had not received injections of trained RNA, there were at most three responses to the click. Among the seven that had been injected, two answered the click 10 times. Again, RNA seemed to be carrying memory.

Species transferral

Since he had earlier transferred learning from one planarian to another by RNA extract, Dr. Jacobson and his coworkers felt it might be possible to transfer learning from one species to another by RNA. They tried making transfers from hamsters to rats and were successful.

One thing was unclear, however. Were they transferring some general ability to learn or the specific training undergone by the donor animal? As a check, they trained two different sets of rats. One set got a food pellet after a click, the other after a light was blinked. Untrained rats received brain RNA from one or the other set of the trained. When tested for reactions to both clicks and flashes, they responded to the cue for which their RNA donor had been trained.

Thus it seemed quite clear that

learning or memories could be transferred from one animal to another, even from species to species, that the transfer was specific and probably by way of RNA memory molecules.

But what looked solid at the end of 1965 was once again under a cloud of suspicion at the end of 1966. During the intervening year over 30 independent attempts to repeat Dr. Jacobson's work had failed. At one point, researchers who had conducted 18 failures at the University of California at Berkeley, Yale, McGill, MIT, Albert Einstein, Squibb Institute for Medical Research and Rutgers got together to write one crushing report. As a result, "McConnell, Jacobson and their followers," notes Dr. Stephen Rose, biochemist at Imperial College, London, are "being continually spurred to produce further evidence," with "experiments and their rebuttals . . . flying back and forth across the pages of *Science* in an emotion-charged atmosphere."

Pressure is felt

The few researchers whose results had agreed with Dr. Jacobson's felt the pressure. "At one time we found ourselves almost alone on the positive side," says Dr. Frank Rosenblatt of Cornell University. "If we had taken a poll we might have quit. But we were too busy doing experiments to stop and take one."

Some transferrers had trouble getting their reports published by a scientific journal. Dr. Jacobson, turned down once by *Science*, the journal of the American Association for the Advancement of Science, sent off his paper to the equally prestigious British publication, *Nature*, where it was accepted.

The debate is on

This was the situation when a symposium on memory transfer opened during the annual meeting of the triple-AS in New York last December. At the first session all seats were filled, standees lined the walls and dozens flopped on the floor in front of the rostrum. The next session had to be moved to a larger room. All those packed in were certainly not working in the field, observed a graduate student doing his doctoral thesis on transfer. Most older faculty members are discouraging young men from doing research in the area.

"Why are we here still trying to decide if there is a phenomenon?" asked the symposium's organizer, Dr. William Byrne, a biochemist at Duke University. He answered: In other branches of science there will be a theory that predicts that if you carry out a particular experiment, you will get such and such a result. When the experiment is done, and the results go according to prediction, one or a few positive results are accepted as enough proof. There was no theory that said transfer would take place. "It is only Monday-morning quarter-

A symposium on memory transfer drew an SRO crowd of scientists and students at the AAAS convention.

backing that has explained the results."

Then there began a parade of the faithful, those who had got positive results.

Dr. Rosenblatt and several others described efforts to make their animal training and testing as automated as possible to eliminate any suspicion of biased observation. In the short history of transfer studies there has been a lot of adjusting of the ways the experiments are carried out. Critics have charged that transferrers keep changing the experiments until they come out right. "Following this thinking," says Dr. Corning, "we should only try once, because if we try again, we might succeed."

Another issue is over what the memory molecule or other transfer agent is. Although the brain extracts are chiefly RNA, it is readily conceded that there are many contaminants that could just as easily be doing the transferring. Dr. Ejnar Fjerdingstad has taken great pains to purify his RNA extract to 1/600th its original amount, and still claims transfer. He and his coworkers at the University of Copenhagen, unaware of what Dr. Jacobson was doing, reported transfer between rats at almost the same time. Dr. Byrne has since lured him to Duke for several months, and he is now working with Dr. George Ungar at Baylor University.

Dr. Ungar ran across transfer accidentally almost simultaneously with the other two. He was studying morphine addiction in rats. When he injected brain extract from an habituated rat into a second animal, he seemed to transfer the habituation. He followed up this chance observation by transferring habituation to a loud noise and to a puff of air in the face. Lately he has succeeded in countering the natural affection of mice for dark holes by transferring to them a trained-in fear of black boxes.

Dr. Ungar still gets memory transfer after treating brain extracts with ribonuclease to destroy the RNA. After treating the extract with the enzyme trypsin, he does not. He concludes that the memory molecule is not RNA, but a peptide.

Best saved till last

Even if RNA were the memory molecule, he says, RNA-ase is too prevalent throughout the body for injected RNA to last long enough to reach the brain.

As at any evangelical meeting, the prize convert was saved until the end. He was Dr. David Krech, a prominent psychologist at the University of California, Berkeley. All the positive results were being reported by the same scientists, he and his associates had noticed.

With a voice steeped in irony, Dr. Krech said: "We set out to settle once and for all whether or not to relegate memory transfer to the file with ESP and other such curiosities and monstrosities of science." They put memory transfer to what they considered the easiest possible test. Other experimenters had put weanling rats in a black box and shocked them repeatedly and given them rest periods in a white box. Four weeks later when the rats were put in a black box, their natural preference, and given an escape door to a white box, they had forgotten the shocks and stayed. A single shock, however, brought the memories flooding back, and they fled to the white box.

Dr. Krech tried training one group, killing them and giving their brain extract to a second trained group as a memory booster in place of the single shock. Of course, they ran into many of the same maddening ambiguities as everyone else. Liver extract, for instance, seemed to work as well as brain extract. But to the extent that there is a transfer of memory reinstatement, the results, said Dr. Krech, "have made a believer of me."

Minutes later one scientist looked out over the departing crowd and said, "I'm surprised there weren't more hatchet men." Had the doubters come to believe, or had they felt it was indecent to hack at a corpse? Judging from their baleful stares, it seemed more likely they had been sitting there still saying, "Show me."

"Do you still think it's a publicity stunt?"

The oldest civilization in Europe

THE discovery of large, egg-shaped stone heads in the ruins of an ancient town in Yugoslavia is being called one of the biggest archaeological finds of the century.

The excitement stems from the fact that the heads, which have blank, staring eyes and open, drooping mouths, may be evidence that civilization existed in the Balkans parallel to the earliest Middle Eastern settlements.

The heads, 33 in all, have been tentatively dated at about 7000 B.C., which would put them in the same era as the Jericho excavations in Jordan. Precise dating will have to wait, however, until radioactive carbon tests are completed at London University.

Dr. Dragoslav Srejovic unearthed the heads three years ago by accident while investigating the ruins of a later culture, the Starcevo settlements, at Lepensky Vir on the Danube. Underneath the Starcevo ruins, which date from about 5200 B.C., were the remains of a still older town.

The older town was laid out in the form of a trapezoid—a geometrical figure with two parallel sides—and each of the 41 dwelling foundations that has been dug out has the same basic shape. In the center of the houses were hearths which may have been used as altars.

The heads, some of which are two feet high, were set in the floors facing the hearths and were apparently images of household gods.

GEOLOGY

Drilling into frozen history

by Benedict A. Leerburger Jr.

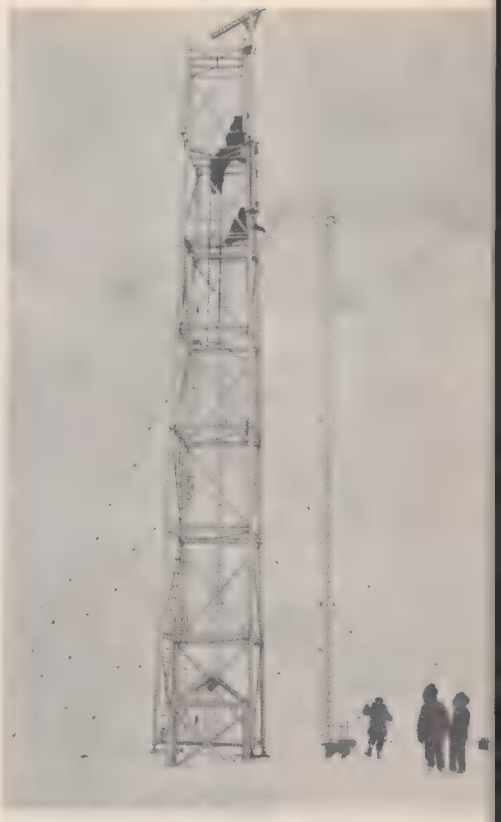
Is the glacial period ending, or are we due for another ice age? What caused the North American ice cap to recede? What have been the world's climatic conditions for the past 30,000 years? These are some of the questions scientists hope to answer by analyzing ice cores removed from an 8,000-foot hole in Antarctica's giant ice cap. It will be the deepest hole ever drilled through ice, in one of the most spectacular probes of earth's deep-freeze, in which may lie many secrets of our planet's geologic past.

The Antarctic experiment actually began in Greenland in July 1966. With a grant from the National Science Foundation, a team of scientists headed by B. Lyle Hansen of the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL), Hanover, N.H., drilled through 4,550 feet of ice at Camp Century. They found small rounded pebbles and silt in the bottom 50 feet of the ice sheet. Twelve feet of sub-ice material (till) was cored before mechanical problems prevented the drill from stiking the scientifically valuable bedrock. The group decided to use the knowledge gained in the Greenland drilling trials to conquer the world's largest and thickest body of ice, the Antarctic ice cap — which covers four-fifth's of that continent to depths over two miles in some places.

In February 1967, the CRREL drilling crew bored a test hole through 711 feet of ice at Byrd Station — less than 700 miles from the geographical South Pole. Instead of the conventional drilling rig used in oil fields, they used a modified electrodrill procured from the Reda Pump Co., Bartlesville, Okla. This is an electrically powered core drill about 90 feet long and 6 inches in diameter which is easily lowered and withdrawn by an armoured cable.

Byrd Station, Antarctica, is subject to some of the world's fiercest weather conditions. Temperatures during the summer drilling season could range from zero to —70°. The decision was to locate the drilling equipment in one of the ice tunnels of the station submerged 40 feet beneath the surface. Although the temperature in the tunnel would be about —20°, the problem of unpredictable winds and storms could be avoided. A 75-foot tower was erected on the surface of the ice sheet to raise and lower the cables onto which the special drilling rig would be attached.

The CRREL crew, using a thermodrill, reached a depth of 250 feet and encased that portion of



ABOVE: Anthony J. Gow of CRREL is shown with a section of a core of ice removed from far below the surface of the Antarctic ice cap. It's his job to make preliminary tests in effort to determine ancient climate. **RIGHT:** Personnel bolting on section of drill tower that stands about 75 feet above surface of ice sheet. Drilling rig is in ice tunnel below surface.

the hole with steel tubing. Then with the special electrodrill using both a steel and diamond bit, the crew was successful in penetrating an additional 461 feet. By then, Feb. 18, 1967, the Antarctic winter was approaching and the scientists decided to suspend operations until spring.

In November 1967, the crew renewed its operations. According to Herbert T. Ueda, drilling expert of the CRREL crew, "Drilling through this ice has been fairly smooth going. Operating the drill at 225 r.p.m., we're able to bore from two to six inches a minute, or about 100 feet a day." Ueda noted that even at a depth of 2,000 feet, some of the original paint still remained on the bit head.

When the 10- to 18-foot-long ice core sections are removed from the hole, they go to Anthony J. Gow of CRREL, whose job it is to make a preliminary study of the ice. Gow places the 4½-inch diameter cores on a V-shaped shelf containing a

Herbert T. Ueda, drilling expert of the CRREL crew, works in the ice tunnel 40 feet below the surface in temperature that stays about –20°. By operating drill at 225 r.p.m., he says that two to six inches a minute can be bored—or about 100 feet a day. An electrically powered core drill is used instead of a conventional oil rig.

light box at the base of the V. He makes a visual analysis to determine if the cores contain any sediment or change in color indicating density variation. The cores are then wrapped in a polyethylene bag, placed in a steel tube and stored in the sub-zero degree tunnel. The tubes are labelled indicating depth of core and the temperature of section of the hole from which the core was removed. A thermister, located in the drill itself, gathers this information.

About 20 separate tubes of ice, totaling about 200 feet, in length, go in refrigerated containers to Hanover, N.H., for detailed analysis. Data gathered from the ice will provide explicit information about the earth's climatic conditions over the past 30,000 years. (The ice sheet is believed to be from 10 to 100 times that old. But since the sheet is continually moving away

A section of ice core is illuminated by light box at base of V-shaped shelf on which core is placed when removed from hole. The 4½-inch diameter core is given visual analysis, wrapped in polyethylene bag, placed in steel tube, stored and labeled according to depth of core and temperature of section from which it was removed.

from the center and breaking off into the waters surrounding Antarctica, no more than 30,000 years of snow accumulation is present at any one time.)

Accurate dating is accomplished by carbon dating the carbon dioxide trapped within the ice cores. The isotopes in the cores act as an historical thermometer. By comparing the isotopes found at a particular depth with a table of known temperature - isotope relationships, scientists will determine what the temperatures were when the snow was first deposited thousands of years ago. Scientists find the earth's former climatic conditions by measuring the electrical conductance of a sample of melted ice to determine specific salt content. The ratio between the Antarctic salts and other salts with known values will help scientists estimate the earth's former climate.

One of the studies under way in New Hampshire will be a microscopic investigation of the ice's crystal structure. With the age of the ice already determined, the crystal analysis will provide valuable information on the stress and strain or dynamics of ice at great depths.

The deep ice is under such great pressure that when a section of core is placed in a container of water at the surface, it snaps and cracks like amplified Rice Krispies. This popping results from the sudden relaxation of the ice under great stress. According to Gow, "A study of the mechanism of ice under these great pressures may explain what causes metal cracking and fatigue."

Gow explained that a detailed analysis of the 8,000 feet of core may reveal what caused a glacial recession 20,000 years ago. In addition, Gow hoped that the ice cores may explain the timing and climatic conditions of deglaciation. "If the cause of glaciation in the United States was atmospheric, then the ice cores will show it," said Gow. "If there were a change in the composition of the atmosphere that might have caused a general climatic cooling, this may explain the cause of glaciers."

Ice sheet moving

Ideally, they would like to penetrate through the 8,000-foot ice sheet and collect samples of soil or glacial moraine trapped beneath the ice. "This will be very tricky," he explained. "We know that the entire ice sheet is moving along the surface at a speed of about an inch a day. Somewhere, probably within 100 feet from the bottom of the sheet, the ice may reach the pressure melting point—where the ice melts and glides along a plane. If we're lucky, we'll get through the pressure melting point and reach bottom before our drill is sheared in two."

From an initial analysis of the cores, Gow has been able to state that, "for the past 5,500 years there has been no melting or deposition of ash in the Antarctic ice sheet."

Dr. Gerhard Fuchs, who led Geological Survey of Austria on expedition to Himalayas, is well-protected in his SPACE Sportsman's Blanket, even though the altitude is 18,000 feet. The 12-ounce metallized plastic blanket evolved from material used in space missions. National Research Corp., Winchester, Mass.

LEFT: Stainless steel flagpole that comes in three sizes (15, 20, 25 feet) can be erected by one man. It is made of three tubes. Two-foot tube, spike and plate are base, mounted in concrete or gravel. Tubing by Wallingford Steel Co., Wallingford, Conn.; poles, W. R. Grace & Co., 369 Washington, Woburn, Mass.

RIGHT: Completely portable radiotelephone developed by Carry Phone Corp., Studio City, Calif., fits into attache case, weighs 12 pounds and has rechargeable battery. Stand-by button leaves phone "open" for incoming calls. Clevite Corp., 232 Forbes Road, Bedford, Ohio, provided ceramic filter for clear reception.

Outdoor electronic sound device to warn blind homemaker it's starting to rain is manufactured by Kenton Laboratories, Ltd., London, and marketed by Britain's Royal National Institute for the Blind. Smallest drop will set off alarm in unit.

A flying saucer that really flys comes from the Olsen Co., P. O. Box 4276-UZ, San Diego, Calif. The toy is over 16 inches in diameter and it has a gasoline engine.

Improved 150 (or 25) gallon marine culture system by Aquarium Systems, 1450 E. 289, Wickliffe, Ohio, has new air pump.

A SCIENCE ADVENTURE

Unveiling the Amazon's secrets

An ultra-modern research ship undertook an expedition up the Amazon last summer and discovered a treasure of scientific data.

by Andrew Hamilton

ONE evening last summer, Russian propaganda broadcasts to Latin America announced that an American expedition had found gold in the tropical Amazon basin —and was smuggling it out of Brazil.

The "news" triggered hearty laughter from 10 sun-browned scientists and 12 crew members of the Scripps Institution of Oceanography's *Alpha Helix*. At the time, the floating biological research laboratory was anchored in the Rio Negro (a tributary of the Amazon), 1,200 miles from the sea. The unique ship had just returned from nine months of probing liana-draped headwaters on an expedition that would interest anyone.

"Sure, we found 'gold,' said Dr. Per F. Scholander, leader of the expedition. "And we're taking it out of the country. It's the gold of scientific discovery."

On her jungle cruise, the *Alpha Helix* carried 82 participants from 12 countries representing 39 institutions that took part in a new kind of scientific prospecting. They found, for example, a "third generation" of pesticides; a possible new tool for cancer research; new clues to the conversion of sea water to fresh; a look at a strange forest phenomenon that may turn out to explain the mystery of how petroleum deposits are formed; data that may provide new methods of preserving tropical fruit for distant markets so that people in New York, London or Montreal can have mangoes and papayas for breakfast.

Dr. Scholander is an enthusiastic 61-year old physiologist whose studies have ranged from the endurance of ski troops in his native Norway to research on mangrove plants in Australia. Among colleagues at the Scripps Institution, he is known as the "Brainstormer."

For years he'd nursed the hunch that an oceanographic ship would provide the ideal vehicle to help a biologist studying animal life along a remote river; to support a botanist in a tropical jungle; an ornithologist investigating sea birds on a lonely island. He discussed the idea with friends. Eventually it attracted the interest of the National Science Foundation. That organization agreed to build and equip such a ship, and to provide a laboratory at the Scripps Institution with concrete pools for studying seals, whales, dolphins and other forms of marine life. Since then, the $3,000,000 "package" has become an exciting addition to the field of biological science.

Floating laboratory

Dr. Scholander's floating laboratory is the 300-ton, 133-foot *Alpha Helix,* named for the spiral molecular structure of proteins and genetic material. The vessel is air-conditioned for tropical voyages; its hull is strengthened against the crush of Arctic ice. Reversible-pitch propellers allow the ship to cruise as slowly as one knot under complete control. Echo sounders scan in all directions.

Investigators can also work from two prefabricated, air-conditioned 8x14 shore laboratories. Carried on board are a small cabin cruiser, several dinghies and a jeep. Float planes and helicopters are leased when needed, allowing researchers to fan out from the ship in all directions.

In 1966, the *Alpha Helix* helped teams of scientists to explore Australia's Great Barrier Reef. It was there that the ship picked up Baxter O'Brien, a jovial Australian cook handyman whose fund of stories and skill with pots and pans are legend. On occasion he has served up shark, sting ray, wild goat, fruit bat and python steaks.

Right now, the ship is at work

1

1. Dr. Kenneth Norris, UCLA zoologist, holds young Franklin's gull, winter migrant to the Galapagos Islands, where scientists stopped on return voyage to U.S. 2. Geophysicist Terry Thomas inspects flightless cormorant in the Galapagos. 3. Dr. Norris putting small microphones in head of bottle-nose dolphin. 4. Flying fish captured by dip netting at night when surface light is shone.

2

in the Bering Sea. Future expeditions are planned to Southeast Asia, New Guinea, India, Africa, the Mediterranean—and return trips to Australia and the Amazon.

Last summer's trip to the Amazon proved the validity of Dr. Scholander's concept beyond question. The great river—incredibly big, incredibly wild, incredibly rich—has been yielding its treasures to civilized man for a long time.

In 1831, the British naturalist Charles Darwin set out on a five-year voyage aboard the *HMS Beagle* that took him to many areas visited or planned for future visits by the *Alpha Helix*—including Brazil. His observation of the differences in animal species led to the formulation of his theory of evolution.

During the first phase of her Amazon cruise, *Alpha Helix'* research projects were led by Dr. Theodore H. Bullock, a neurobiologist from the University of California Medical School, San Diego. Efforts were concentrated on experimental studies of the brain, sense organs, muscles and behavior of such creatures as fresh-water sharks and rays, electric fishes, echo-ranging dolphins, piranha fish, great water snakes, anacondas, lungfish and bats.

The exploring scientists uncovered a host of curious facts

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about these creatures. The pink, fresh-water dolphin, for instance, has a completely different and higher-pitched voice than his sea-going cousin, they learned.

The boa constrictor, though not equipped with ears, can hear. It also has highly-sensitive heat receptor organs in its lips that are used to detect unseen prey.

The electric eel can develop its lethal shock only if the water is just right—not too soft, not too salty.

The feared piranha is really a solitary, usually unaggressive fish, preferring to attack crippled victims his own size or smaller, and is little attracted by blood.

"Studies of these lower forms of life reveal that many of their nervous and muscular responses are similar to those of man," Dr. Bullock reports. "If we can learn exactly how their organs work, we may gain a better understanding of the more complex systems in life forms such as man."

He points out that the air-conditioned *Alpha Helix* carries as much up-to-date equipment as a good laboratory in San Diego: centrifuges, spectrophotometers, scintillation counters and oxygen analyzers.

Several women scientists also took part in the expedition. Prof. Hebe Martelli, University of Brazil, discovered bacteria native to the Rio Negro can reduce sulphur compounds in waste materials found in water. The finding, it is hoped, will point the way to break-up of industrial detergents that pollute our rivers and lakes, according to Dr. Scholander.

One lady scientist provided a memorable incident when she took a short canoe trip up one of the tributaries flowing into the Rio Negro. She was followed in the water by a tapir—an animal resembling a large pig with a long snout. Squealing and puffing, the creature swam behind the canoe and even tried to climb inside, tipping it over. The lady righted the frail craft with one hand, while straight-arming the over-friendly animal with the other, and headed back toward the *Alpha Helix* with tapir in hot pursuit. The incident is re-

ferred to as "The Lady and the Love-Sick Tapir," in the oral annals of the expedition.

During the endless, steaming days on the Amazon itself, Dr. Scholander pursued studies of how mangrove and similar plants that grow in salt water draw moisture through their roots and convert it to fresh water. The curious process is called "reverse osmosis."

A lesson from leaves

"Little glands in the leaves pump out excess salts," explains the scientist. "The system is extremely simple but highly efficient. It may teach us something about desalting sea water."

Throughout July and part of August, Dr. Carroll M. Williams of Harvard concentrated on the relationship between insects and plants. He had long suspected that substances known as "juvenile hormones" might turn out to be the "third generation" of pesticides.

He found the hormones in abundance in the Rio Negro, which is almost as brownish-black as a cup of strong tea. Light does not penetrate beyond a depth of six feet. The color comes from the saps and juices of several thousand square miles of dense Amazonian rain forests.

Juvenile hormones must be present at certain stages of an insect's development or it will die; at other times they must be absent or the insect will develop abnormally. Dr. Williams estimates that one gram of a pure hormone will kill a billion insects—but will not harm other forms of life.

While Dr. Williams scooped water samples and netted thousands of flying, crawling and buzzing bugs, Dr. David Prescott of the University of Colorado was busy with a strange, green-spotted microorganism that may provide an important research tool in the search for understanding of how single cells become multi-cellular organisms.

This particular organism, which lives near the equator, is accustomed to a day that has 12 hours of light and 12 hours of darkness. When dropped into the black waters of the Rio Negro, individual cells disassociate themselves from the colony, rise to the proper light level, then clump together again.

"Though it may be a long step," Dr. Prescott points out, "any better understanding of how these cells divide and grow must lead to a better understanding of cancer."

From Aug. 15 to Oct. 1, Dr. Jacob Biale of UCLA, and scientists working with him, studied respiratory patterns and ripening processes of cultivated and wild fruit plants of the Amazon basin.

"We want to learn how fruits ripen and what happens to them when they are stored and shipped," he says. "Modern packaging methods and refrigeration can slow ripening, so there is no reason why fresh tropical fruits cannot become a staple item on the table."

One of the most curious, and per-

As plans are made for additional Alpha Helix trips, explorers hope for more scientific "gold."

haps significant, studies performed on the cruise was conducted by Dr. Frits Went, formerly of Cal Tech, and now the University of Nevada. He investigated the "blue haze"—sometimes mistaken for smog—that one sees hanging over forests in many parts of the world, including the Amazon. It is caused by microscopic oily substances known as "esters." Trees and shrubs give them off through pores in their leaves. Over eons of time, Dr. Went theorizes, these substances are washed out of the air and down to the mouths of rivers, forming one basis for petroleum deposits.

On the return voyage to the United States this past winter, *Alpha Helix* detoured to the Galapagos Islands, where Dr. Malcolm Gordon of UCLA and associates studied the physiology of deep-sea fishes.

Hopes for the Arctic

"We want to go to Arctic waters to study warm and cold-blooded animals, problems related to freezing and atherosclerosis (a form of arteriosclerosis), in migrating salmon," Scholander reveals.

One of the plus factors of the *Alpha Helix*' voyages to remote corners of the globe is the involvement of local scientists. In Australia, a number of down-under scientists took the opportunity of working with highly-sophisticated laboratory equipment on the Great Barrier Reef. In the Amazon, 20 Brazilian scientists participated, including Professors Paulo Sawaya, Martelli and Paulo Alvim, and Commander Manuel de Oliveira Perez, of the Brazilian Navy.

From now until next September, some 50 scientists from five nations will be cruising iceberg-strewn seas north of the Arctic Circle—from Nunivak and St. Lawrence Islands to Point Hope. They'll probe the Bella Coola River in British Columbia. The Coast Guard's icebreaker, *Northwind,* will lead the *Alpha Helix* through the ice pack. Scientists will be hard at work in slick new laboratories aboard both ships; two helicopters on board the *Northwind* will whirlybird them back and forth to drifting ice floes, glaciers and points of interest ashore. They'll be working on the strange physiological systems of sea birds, walruses, seals, otter, reindeer, eel pouts, crabs, musk ox and other creatures.

"In marine mammals, flukes are ice cold but the body is warm," says Dr. Scholander. "Why is this? Why are we and Eskimos so sensitive to snowblindness, when arctic animals and birds are not?"

These and many more questions may finally yield answers as the *Alpha Helix* pioneers the frontiers of science.

Marmosets — the world's smallest monkeys

by Barbara O'Connell

MRS. Germaine Miller, a tall, fashionably-dressed blonde, boarded the boat train at Paris a few years ago for the trip to the English Channel. She carried two purses, one of expensive leather and the other a small wicker affair. As the train was rolling through the French countryside, the passengers heard a shrill chirping noise. "There must be a cricket in here," exclaimed someone. Everyone looked around, but no insect was seen. The chirping noise continued.

Later, after she and her fellow passengers had passed through customs, Mrs. Miller offered to exhibit the "cricket". She opened the wick-

er basket. Inside was a tiny, brown, furry creature with a long tail and an almost human face.

It was a monkey, but a special kind of monkey. Mrs. Miller, who lives in Westchester County, N.Y., raises pygmy marmosets, the smallest monkey in the world. The animals are, in fact, the smallest living primate. Excluding their tails, they average four inches in length in the wild and an inch or so longer in captivity. They weigh only a few ounces.

They travel light

An animal this size is easy to carry around, and Mrs. Miller and her husband, Roswell, tote one or more pygmies (they have three at present) with them almost everywhere they go. The animals have been on airplanes, trains and ships, and in cars, beauty shops, restaurants and stores. Chou-Chou, a five-year-old female, has visited Europe, Canada and Puerto Rico, as well as Florida and the western states.

"People don't know we have a monkey with us—they just think I'm crazy for carrying two purses," says Mrs. Miller.

So far as she knows, Mrs. Miller is the only person in the country raising pygmy marmosets. Delicate and high strung, the little creatures are hard to keep alive. Even larger marmosets are difficult to raise. Irving Levane of the New York Simian Society, an organization of monkey owners, knows of no marmoset owners in the area, although he estimates there are 10,000 to 20,000 owners of other kinds of monkeys in Greater New York. Most pet store owners have stopped stocking marmosets. "We come in in the morning and find them dead in their cages," says one animal dealer.

What makes marmosets so hard to raise?

According to Dick Bergman, who's in charge of the monkey house at the Bronx Zoo, "South American monkeys like the marmosets are always harder to keep healthy. If they don't get extra calcium, and Vitamin D, they go down with rickets, TB or colds." With the right diet, however, Bergman thinks the marmoset has a good chance of survival in captivity. The "right diet" would make most people pause. Besides fruit, insects and special formulas brewed by Bergman in the zoo kitchen, it includes mealworms flown in from California—an absolute must in the marmoset diet.

Not the "perfect" pet

The diet works, though. The zoo's common marmoset died recently at the age of 14, which is about as old as a marmoset has ever lived to be in captivity. At present, there are 10 marmosets in Bergman's charge—seven white-faced, one cotton-topped, and two pygmies —all of them in good health.

Not everyone would like the marmoset as a pet even if it could be kept alive easily, Bergman cautions. Marmosets are shy, nervous mon-

Marmosets usually bear two young which father carries around on his back, handing them over to mother at feeding time. Newborn pygmy marmoset (below) takes milk from eye dropper held by Mrs. Miller. Eyes are open, teeth present at birth.

keys, likely to bite when excited (Mrs. Miller has been bitten so many times she has lost count). Owners may find their pet less than enchanting when it sinks all 36 of its needle-sharp little teeth into their hand. "That's when we get all our 'donations'," smiles Bergman.

Mrs. Miller expresses some bewilderment about her unique success. "People are always asking me what I do; my marmosets are so healthy. I don't know." But a description of her daily routine is revealing. Before the pygmies go outside in cold weather, she dresses them in minute sweaters, which she knitted herself, to protect their lungs. In the home, the animals never run around on the floor. "Never," she cries, exhibiting tiny chains made out of a number of inexpensive children's bracelets by which the monkeys are tethered to rings in the windowsill.

At dinnertime, the creatures perch

on Mrs. Miller's dining room chair and eat bits of food she presents to them. "I give them tidbits—they eat their mealworms themselves." The "tidbits" vary with the meal. On the French Line, the well-traveled Chou-Chou developed a fondness for lobster and ice cream. Like Dick Bergman, Mrs. Miller improves her pets' diet with food supplements combined in a formula she concocts herself.

No veterinarian for pygmies

Sick marmosets visit Mrs. Miller's personal physician, not a veterinarian. Mrs. Miller doesn't have a high opinion of veterinarians. "They don't know anything about monkeys," she says. "Dogs, cats, perhaps, but not monkeys." She travels with a medicine chest, not for herself, but for the monkeys.

Her pygmies are exceedingly well-trained. "Do pee-pee, do pee-pee," she tells Chou-Chou, presenting her with a paper napkin, and Chou-Chou obligingly does so. "One of them sleeps with us, but it goes to the toilet every night before it goes to bed, so there's no problem," she remarks. The marmosets also have a "trick." "Give me a kiss, Coco," she commands, holding him in her hand. The animal bends forward and pecks her nose with its lips.

Mrs. Miller estimates that she spends "all her time for three months" with each animal after it's born. The procedure obviously pays off. In 10 years, she's had some 15 marmosets, most of which have lived to respectable age with her. One marmoset acquired from a pet shop as an adult lived with Mrs. Miller for over seven years before it died. One of the current pygmies is five. The others—twins like most marmosets—are three. Even more impressive, perhaps, is the fact that her animals have produced 12 young, most of which have survived.

Does Mrs. Miller recommend marmosets for the average pet lover? "No!" she says. "People don't know how to take care of monkeys. Every marmoset but one that I've given away has died."

In the past, however, marmosets were very popular as pets. Sixteenth century voyagers from Spain and Portugal saw the tiny animals being kept as pets in the Amazon region, and brought them back to Europe. They soon became a fad among the aristocracy. Women were fond of them, carrying the furry mites around in their capacious sleeves. The name "marmoset" is believed to come from the Old French word "marmouset," which means a grotesque figure or manikin.

All species are tiny

The marmosets taken back to Europe by these early explorers probably included a variety of the 30 or more species of marmosets. The pygmy is the smallest, but all of the marmosets are small—collectively, they're the smallest monkeys in the world. Because of their size and dense fur, observers who spot them from a distance often mistake

them for a kitten or a squirrel. Up close, however, a marmoset's expressive simian features mark it as a monkey.

If you approach the white-faced marmosets at the Bronx Zoo, they'll dart as far away from you as possible, raising their brows and contracting their lips in an expression of alarm. When Mrs. Miller pulls a sweater over the head of one of her pygmies, it contorts its face with rage while it chatters angrily.

The marmoset's hands also mark it as a monkey, but a primitive one. Fingers move in the same plane, so that it must press an object against the heel of its palm to hold it. Each of the long fingers is provided with claws rather than nails, a peculiarity that distinguishes it from all other American monkeys.

Assorted varieties

All marmosets share these traits, but the colors of their coats and other superficial features divide them into a number of species. Exactly how many is unknown. A few may simply be local varieties. Marmosets exhibit an astonishing range of colors and patterns in their coats, as well as a spectacular assortment of tufts, plumes, manes and even mustaches. The grandest-looking is probably the lion-headed marmoset, one species of which has bright golden fur over its entire body, including the lion-like mane. Other species display patches of golden fur. A second candidate for the most outstanding marmoset honors is the aptly-named white shouldered marmoset, which has a white head, chest and face, as well as white ear tufts. The silver marmoset is all white, a pure, silvery color that seems more appropriate for the Arctic than the jungle.

One imperious-looking creature, the emperor marmoset, has, around its mouth, long white hairs which fall to its shoulders like an overgrown mustache. The plumes of white hair on top of the head of the cotton-topped marmoset make it resemble a Masai warrior. A number of marmosets boast eartufts (see cover) either in the form of long, drooping hair that arises in front of the ears or corollas of stiff hairs that grow all around the ears.

When a marmoset is angry, this abundant fur stands out—an impressive sight even in so tiny a creature. If you approach Mrs. Miller's Chou-Chou when it's eating one of its favorite treats, a miniature marshmallow, the little animal will cram the marshmallow in its mouth, lower its brow and literally swell with rage.

Later, if Chou-Chou lets you touch its fur (wild marmosets dislike being handled, but the Miller marmosets have been trained to submit to it) you'll find it's almost as soft as down. The fur of even the larger marmosets is soft and silky.

With coats like this, it's not surprising that some authorities consider marmosets the most beautiful of the monkeys. But not all marmosets are attractive. The silver

Talkative marmosets have a large repertoire of calls, many produced only in response to particular objects.

marmoset has a gorgeous white coat, but its ears and face are naked pink skin with red blotches. The top of its head is bald, too. Quite a few marmosets are bald. Martin's Marmoset has a bald head described by one naturalist as being "a sickly puce." The baldness is not the result of falling hair; bald marmosets are quite simply born that way.

For a small creature, the marmoset makes an enormous amount of noise. To the uninitiated, these cries often sound like those of insects or birds rather than monkeys. But when it wants to, the marmoset can make these shrill sounds carry for some distance. When one of the Miller marmosets is in the first floor living room, it can easily make itself heard in a second floor bedroom of the large (30 rooms) house.

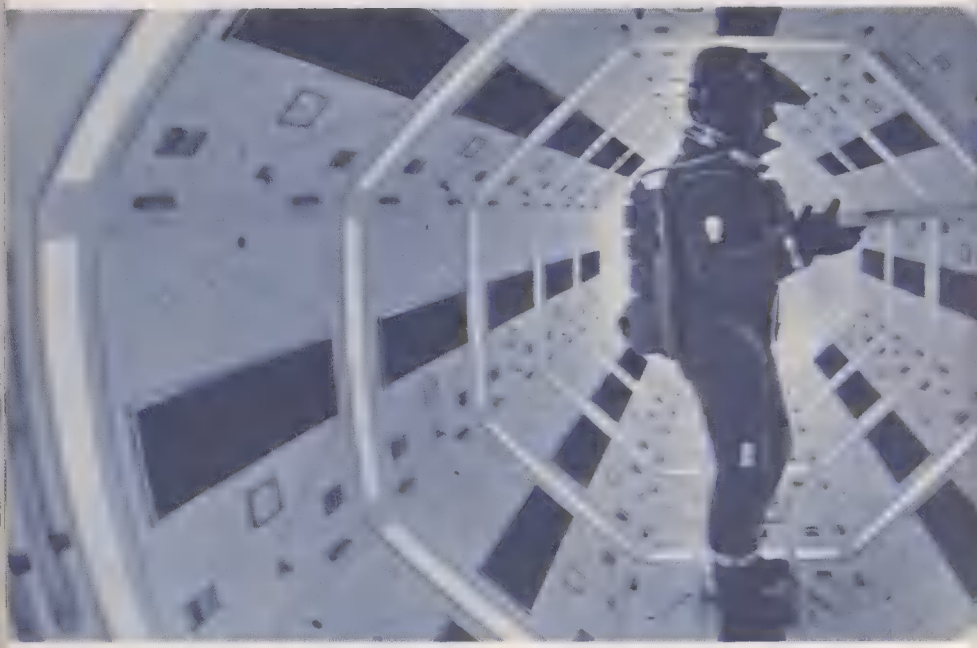
Marmosets have a whole repertoire of noises. According to one authority, the black pencilled marmoset has different cries for contempt, anger, hunger, fear and even boredom (pseeeh, pseeeh). Another naturalist claims that marmosets have a "limitless number" of calls, many produced only in response to certain objects, such as a black dog or a cake of soap. Mrs. Miller notes that her pygmy marmosets greet a black poodle belonging to her daughter with a cry reserved especially for that particular dog.

Marmosets not only utter cries in isolation; they talk to each other. "My Mimi used to call the roll of her children when we went on vacation," says Mrs. Miller. "And each one would answer." When Mrs. Miller and her husband drive in their car, one marmoset is usually perched on Mr. Miller's shoulder while the others occupy a closed basket. As the car nears the Miller home, the "outsider" calls to the monkeys in the basket, seemingly telling them they are near home, and the others answer.

Always chattering

For one reason or another, then, marmosets seem to be talking most of the time. "They're always chattering," says Dick Bergman. If you sit in the living room of the Millers' apartment in New York City, an almost constant chirping and trilling is heard from the kitchen, where two marmosets occupy separate baskets on the sink. We may not even hear all the sounds marmosets make. Sensitive equipment has recorded marmoset sounds which are too high for humans to hear.

Talkative, pretty and tiny, marmosets have an almost immediate appeal for anyone who comes across them. According to the experts, though, a marmoset is better off in the jungle or a zoo, unless you're fantastically patient.



How they made 2001

by Richard Dempewolff

ARTHUR C. Clarke, noted authority on outer space, picked his way carefully across the surface of the moon a few paces ahead of me. Off to our left was the crater, Tycho. There was a pile of moon dirt near the rim where they'd been excavating for a weird magnetic anomaly that had been diverting all the compasses of our moon colonists.

"You're standing on the landing pad for the *Aries 1B* moon shuttle," Clarke called back over his shoulder. "Be careful not to step on any moon base buildings. They're plaster. They'll bust."

We were exploring a 30-by-30-foot model of the moon's landscape on top of a three-story-high scaffold in MGM's Borehamwood studios, near London. Far below, on the floor, several full scale space ship command modules were under construction, abristle with instruments, buttons, flat tube color TV monitors, computer gear and multicolored lights. For months, in the

Science fiction writer Arthur C. Clarke, director Stanley Kubrick and a host of experts and technicians have teamed up to bring to the screen a startlingly realistic view of life in space in the year 2001.

sprawling complex of studios, cameras had been filming eerily-lighted sequences of spectacular vehicles moving through the solar system; interiors of orbiting space ships in which "weightless" people walk up walls and cross ceilings upside down; fantastic scenes in a pinwheeling 42-foot centrifuge inside *Discovery*—a deep space probe on its way to Jupiter with a voluntary crew of one-way explorers.

I was witnessing the wrap-up of a gargantuan four-year effort by director Stanley Kubrick, and an army of experts, to produce a zoom lens view through time of our future in space — a movie entitled *2001: A Space Odyssey*. The film story written by Kubrick (a demon for perfection) in collaboration with Clarke, is based on a book Clarke wrote called *The Sentinel*.

As Arthur Clarke tells it, by the year 2001 our first moon colonists have established a base of 1,000 people in preparation for a manned probe of deep space. A wheel-shaped space station 600 feet in diameter, which spins to provide gravity, has been assembled in orbit 200 miles above the earth. *Orion*, a rocket-driven vehicle resembling a conventional airliner, with delta wings for earth landings, shuttles about 40 passengers at a clip between the earth and the space station. *Aries 1B*, a rocket-propelled bubble about 50 feet in diameter, ferries people between the space station and the moon base in a completely weightless environment.

At the moon base—a science-oriented village similar to our isolated Antarctic ice cap stations, nuclear power plant and all—colonists buzz around in a moon bus equipped with its own air and climate. It's an ordinary-looking bus. "The lunar landscape is not very dramatic, we know now," says Clarke.

Adventure begins when moon

base instruments go haywire due to a powerful magnetic field near the crater Tycho, during lunar night explorations. Men dig and unearth a huge black monolithic artifact, apparently put there by intelligent beings. Atomic dating places its burial 4,500,000 years ago. Then, lunar day dawns. When sunlight hits it, the thing emits four powerful radio beeps.

"It's an alarm clock," explains Clarke, "set as a trap for earth's baby civilization — to warn some super intelligence that man has taken his first step out into the galaxy. Its magnetic label indicates the 'thing' was *meant* to be found."

A one-way trip

Who put it there? By querying our own artificial satellites regarding their position, and the intensity of the beeps at the instant they received them, scientists determine that the monolith's signal cone was beamed at the Jovian system.

Earth people already have plans for a deep space ship, *Discovery*—a giant affair 600 feet long, powered by fission plasma drive. The crew rides in a 50-foot sphere at one end. A 42-foot centrifuge within the sphere provides gravity for the men. Planned for nearer planets, *Discovery* only has a one-way capability for Jupiter. But the decision is made to go anyway. The great ship is assembled in space from packages launched into lunar orbit. Five volunteers are picked for the voyage. During the eight month trip, traveling up to 5 million miles a day, they rotate duty; two on and three off. Those off duty hibernate in cryogenic (deep freeze) "coffins," where they are fed intravenously. The Jupiter trip comprises the major part of the story.

What the explorers find is enough to make flesh creep—and so were the myriad problems of staging this far out extravaganza.

Kubrick and Clarke insisted that every piece of hardware — every ship, system and procedure in the picture—had to be based on known, workable principles—both in operation as well as design. Not only did buttons, lights, monitor screens and console controls have to be realistically accurate in makeup, many things had to *work* for the cameras.

Since no one has yet been to the moon, much less to Jupiter, it wasn't easy. The team that bore the "feasibility" burden included three indefatigable wizards: Fred Ordway, scientific consultant who researched the problems posed by Clarke's story and got scientific answers; Harry Lange, the designer who took Ordway's technical data and drew plans for workable space gadgetry no one had ever seen; and Tony Masters, an ingenious builder who turned the plans into practical hardware no matter how "impossible."

"Tony is the real hero," says Clarke. "His ships and hardware are not just *possible* devices for our future in space; they're highly

The space devices shown in 2001 are not just possible, they're highly probable, says Clarke.

probable." So precise and logical are 2001's space vehicles that the National Air and Space Museum has requested them for permanent exhibit when the picture is finished.

How do you design equipment that doesn't exist, for situations of which little is known?

Detailed "specs" and drawings for an advanced fission plasma rocket capable of sending *Discovery* to Jupiter, were prepared from existing plans and components by Thomas F. Widner, General Electric's manager of advanced nuclear programs.

Discovery's command module was designed by Harry Lange, working with G.E. experts for accuracy, and with NASA "specs" on human biological capabilities for practicality. IBM development people, under Elliott Noyes, made workable plans for a fantastic red-lighted computer for the lunar module—exactly as it would have to be for a lunar computer. With Minneapolis Honeywell experts, they designed a whole new family of computer units adapted to space ship use, along with accurate panel displays, button and controls for every console shown in the film.

"The hibernation sequence was a beaut," Ordway recalls. "Little is known on the subject." But doctors at New York University Medical Center, and Harbor General Hospital in California, familiar with work in the deep freezing of live animals, moved in with technical details so that Lange could design authentic controls and containers that human cryogenic hibernators would require. In the movie, you'll see men climb into plexiglas freeze containers shaped like sarcophagi, where they are frozen to sleep.

Authenticity at all costs

Efforts to maintain scrupulous authenticity were endless. "On the *Discovery* voyage, communications is a key link, since these men will not return," Clarke points out, "For instance, there's a two-hour time lag in message relay at the farthest point. You can't have normal conversation and be realistic. So, in the film, it's like sending telegrams back and forth."

NASA even provided a 50-word lexicon of Apollo mission control jargon.

When detailed contour charts and maps of the moon were needed, Ordway couldn't find any good enough. He had them made at Pic du Midi Observatory in the French Alps. They are so accurate—even down to magnetic contours extrapolated to the moon situation—that they can (and may) be used for our real moon landings in a few years.

All the expertise in the world couldn't solve the problems of filming an outer space movie in the

gravitational field of earth—compounded by the limitations of movie studios. "Our biggest problem was weightlessness," says Masters. "How do you show people walking up walls and floating naturally in space?"

Usually, movie studios perform this kind of trickery with "matte shots"—two exposures superimposed. But Kubrick wasn't having any. Actions of people and movement of floating objects would have looked "phony." They tried shooting action under water. "Bubbles showed," Masters recalls. Hanging people on wires resulted in movements grotesquely remote from reality, and the wires glimmered.

Walking up walls

Solutions were highly ingenious. In one sequence, on *Discovery,* one of the crew walks down a corridor, up a wall, across the ceiling and through a doorway upside down. To get it, the camera was bolted to the deck at the near end of the corridor. The actor, walking away from the camera to the far end, turned left and started up the wall. At that instant, the entire set rotated to the right taking the camera with it. The actor, of course, remained vertical as he walked around the revolving set. But on film he appears to be hiking up the bulkhead until he is standing upside down on the overhead.

"What we have done is very close to reality parameters," Ordway points out. Actors learned to simulate the slow-motion actions of a zero gravity environment by studying Langley Research findings from moon gravity simulators. "In a real space ship you'd use magnetic floors and shoes," says Ordway. "Walking movements would be slow and jerky. We discovered we could produce the same effect by walking people down an incline plane. So that's how many of the scenes were shot. The camera was placed at the angle of plane to create the proper illusion." To heighten the effect, Velcro was used on floors and shoe soles, so they'd grip each other like zippers.

"It was very funny to see people try to walk at first," Ordway recalls. "Especially on the vast curving floor of the space station set. They'd waddle, then step forward gingerly as though feeling their way in the dark."

There's no way to fake a space ship centrifuge. So the giant revolving living quarters of *Discovery,* where most of the action takes place, was built full scale right in the studio. The 38-ton wheel, 42 feet in diameter, kissed the studio girders. In space, to create one sixth of earth's gravity (a force equal to moon gravity), such a centrifuge would have to spin at two rpm. So that's what it did in the studio.

"Then we had to find a way to shoot film inside the centrifuge, showing it revolving," says Tony Masters. "The cameras had to show people walking every way including upside down. One sequence had to show a command pilot running all

The hardest technical problem was to simulate weightlessness without using trick photography.

the way around."

The men devised revolving contacts for the cables so they wouldn't knot up, and fed all services—including air conditioning—through the hub. "The thing looked like a fourth of July ferris wheel with all the lights on it going around," Tony recalls. Sixteen projectors inside the wheel provided read-outs on the consoles. The camera rode on a remote control dolly, its power cable dangling from the hub, allowing it to move counter to the wheel and stay out in front of the actors. Anchored to the rim of the wheel, it could take "upside-down" shots.

It wasn't all ice cream. "Lights around the centrifuge were big 10Ks and 5Ks," says Masters, "and they didn't like going around. They'd blow up inside the thing while we were shooting. Glass shattered, rained down on the actors and went tinkling around the walkway as the thing revolved. And one day some knothead left a loose junction box lying around and it began banging down on the set every time it achieved enough altitude to fall."

Gravity, and simulated lack of it, weren't the only headaches. You'd think that all you had to do would be to put a command pilot astronaut in a space suit and start shooting the dramatic sequences in the command capsule. Not so. He can't breath. He sweats. He steams his visor. This happened in the trials. Result: Tony Masters' crew had to rig a genuine air supply to each space suit. So, 2001's astronauts are genuinely equipped for space.

Current developments in our actual space program have had a profound influence on this cinematic cosmic invasion.

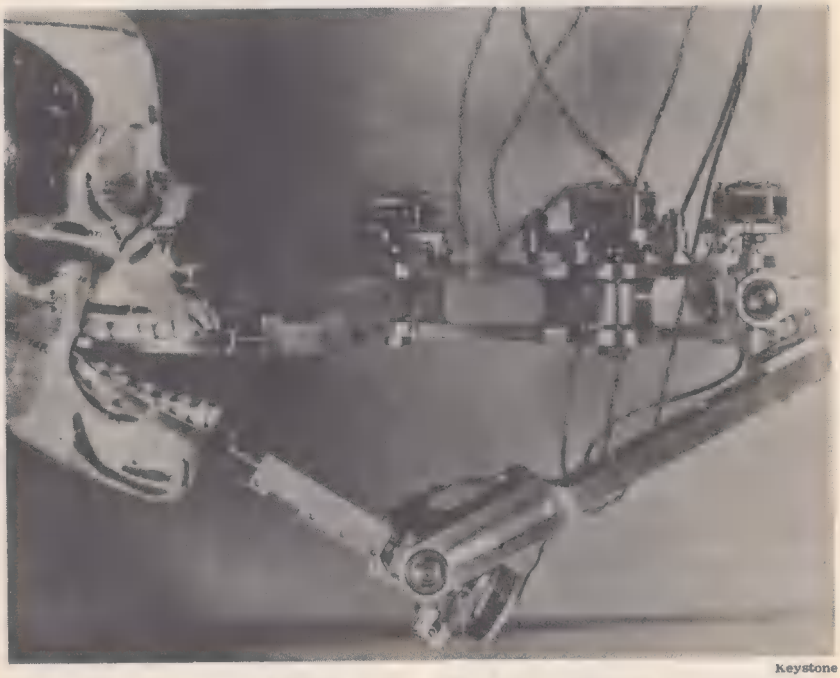
"There's a sequence showing the earth ferry docking in the space station," says Masters. "It had never happened, so what kind of equipment do you need? Everyone took a crack at it. First we used a mechanical nose grabber. Then, on the basis of the nose-into-cone Gemini dockings, we found it wasn't necessary, so the space station design was modified to conform. Now, in the picture, *Orion* is held in place by two side grabbers."

How does it end?

For weeks Stanley Kubrick and Arthur Clarke fretted about whether, in the airless lunar sky, you'd see far more stars than we do here. They finally decided that, since earth is 50 times brighter than the moon—viewed from the lunar vantage—it would wash out stars rather than make more of them visible. Surveyor proved them correct. "In fact," says Clarke, "Surveyor confirmed everything we had done."

How does this fantastic movie end? You'll have to see it to find out.

Science Month



Keystone

The complicated motions of the human jaw can now be analyzed accurately by means of an electronic device designed by a mechanical engineer at the General Electric Co. This jaw motion measurement device measures the six angles of jaw movement in inches and degrees of rotation. It is considered an important advance in the field of dentistry.

Built-in obsolescence of life

MAN has built-in obsolescence. Even if he conquers all other causes of aging, he'll succumb to the ultimate failure of his normal cells to divide or function.

Working with normal fibreblast cells from the lung tissue of humans, Dr. Leonard Hayflick of Stanford University has demonstrated that the cells from living persons double about 50 times in a culture, then die. When the cell division is interrupted—by accidental death—the fibreblasts "remember" the level they had reached and go on from there.

Cells taken from adults at the time of death underwent doublings

roughly correlated with the age of the donor, he found. Cells taken from persons who died between birth and 20 years of age underwent about 30 divisions. Cells from donors who died after 20 divided around 20 times.

The cells of shorter-lived vertebrates showed less capacity for division. Fibreblasts from embryos of chickens, rats, mice, hamsters and guinea pigs usually doubled no more than 15 times in a culture. Adult fibreblasts from these animals underwent considerably fewer divisions.

It has not yet been established that fibreblasts behave the same way in living animals as they do in a culture, but the weight loss in old age in several human organs has been attributed to cell loss, Dr. Hayflick points out. The human brain and kidney both weigh less in old age than in middle age.

What, then, determines man's life span? Dr. Hayflick thinks it may result from the deterioration of the genetic program that controls the development of his cells. Man's repair system for correcting errors in his programming is more effective than most animals', but it, too, eventually fails.

Footballers quench thirst

Researchers have found that football players working out for two hours under Florida's hot September sun lose an average of 7.7 pounds each, most of it through perspiration. When a person drinks water, it must reach what they call "osmotic equilibrium" before the body can absorb it, so trainers and coaches discourage drinking water during strenuous activity.

Now, however, researchers have come up with a solution of water, salts and glucose that closely matches the extra-cellular fluids of the body and is absorbed about 12 times faster than water by means of a process called isotonicity. The scientists have dubbed the beverage they concoted Gatorade. Football players have found they can guzzle a gallon and a half of lemon-lime flavored Gatorade per game.

Cooler smoke safer

Replacing existing brands of cigarettes with a variety made to burn at a lower temperature might save many thousands of lives each year.

A scientist at the University of Melbourne, Australia, painted the skins of 12 mice with extracts from low temperature cigarettes and 12 with extracts from a popular commercial brand. None of the mice exposed to the low-temperature cigarette extract suffered any permanent skin damage. Eight of the animals painted with the com-

With the new Honeywell helmet sight, pilots can aim weapons merely by looking at a target. Engineer demonstrates how pilot's hands and mind are freed for task of flying. No mechanical link to cockpit is needed because beams of light determine exactly where pilot is looking.

mercial extract developed a condition which commonly precedes the development of cancer.

New Scientist, a British publication, calls these results "highly significant."

The Australian scientist, Dr. E. R. Trethewie, explains that the hydrocarbons in tobacco crack when the temperature reaches 700° C. One of the results of the cracking process is the cancer-producing chemical, benzpyrene. Cigarettes that smouldered at temperatures of 100-200 degrees lower should be safe, he argues.

"Whether low temperature cigarettes would taste so good and whether (if they didn't), the dedicated gasper addict would be prepared to sacrifice a small part of his pleasure for the sake of avoiding the risk of a peculiarly unpleasant death is, of course, entirely another matter," notes the publication.

Scientific egg hunt

An unusual kind of egg hunt will take place in Wood Buffalo National Park in Canada's Northwest Territories this spring, the *Chicago Tribune* says. Scientists from Canada and the United States will lift the eggs of whooping cranes from their nests and fly them to Patuxent Wildlife Research Center in Maryland for hatching.

Since whooping cranes usually lay two eggs, one egg will be left in each nest.

The egg lift is designed to increase the small number of whooping cranes by adding the offspring of captive breeding pairs to the young reared in the wild. Last year, the first year the plan was tried, four young whoopers were raised at Patuxent from six eggs. This is a much better survival rate than in nature, where only about a quarter of the birds reach maturity.

Eventually, scientists hope to have 10 to 20 breeding whooper

pairs at Patuxent. One pair of whoopers in the San Antonio Zoo was bred for the first time last year and their offspring are also at Patuxent.

In all, there are only 59 whooping cranes in existence, including both wild and captive birds. The whooping crane picture is definitely brighter these days, however. Last year, 48 whoopers returned to the government refuge at Aransas Pass, Texas—five more than the previous year, and a 30-year record. In the flock were nine young, four more than in 1966.

The American scientists will fly to Canada to participate in the egg hunt when aerial surveys by the Canadian wildlife service indicate that the eggs are nearing their 14th day in the nest. Last year, the whooper egg hunt took place in June.

High-jumping flea

Research workers at Edinburgh University, who have been studying various types of fleas, have found at least one variety that can jump seven inches in the air. That's the equivalent of a man jumping 300 feet.

La Porte weather: All bad

To residents of La Porte, Ind., their weather seems worse than it is anywhere around. It's a funny thing, the *Christian Science Monitor* reports, but the weather *is* worse.

Stanley A. Changnon Jr., of the Illinois State Water Survey, told a recent meeting of the American Meteorological Society that La Porte has more hailstorms and thunderstorms than surrounding areas. Many of the storms come in early morning, an unusual time.

From 1951 to 1960, he said, La Porte had 84 days with hail compared to 43 days for the next hardest-hit station within a hundred miles. From 1951 to 1965, La Porte had 38 percent more thunderstorms

The Royal New Zealand Air Force P-3 Orion usually used for antisubmarine warfare search missions and rescue operations, recently had an unusual job—charting the birth of an island. The new volcanic island is part of the Tongan Group located north of New Zealand.

Pictorial Parade

"Cell 4" is the name of a new engine test laboratory run by the British government. The lab will not only test engine performance but will also try to find ways of reducing the noise level of jet engines. Pictured above is an engine in the sound free chamber at "Cell 4".

than surrounding areas.

The blame, Changnon thinks, rests on the Chicago-Gary region 30 miles away and on La Porte itself. Urban areas, he explained, produce more rain in three ways: by adding heat, water vapor or nuclei in which ice crystals freeze and grow into raindrops.

The industry in the Chicago-Gary complex provides plenty of nuclei and the industrial-urban heat source maintained throughout the night is probably responsible for La Porte's early morning storms, the water survey official notes.

Ironically, the man-made increase in storms at La Porte exceeds anything man has been able to do deliberately in the way of rainmaking.

Deer ignore booms

Deer herds near the low-level bombing ranges of Eglin Air Force Base, Florida, show no awareness of repeated sonic booms of greater than normal intensity, according to an article in *Physics Today*.

On the average, the magazine maintains, there is a definite trend towards increased tolerance of sonic booms by the ones most familiar with them. Certain individuals, however, are hypersensitive to transient noises and for these and for some types of animals, adaptation may be difficult.

Well-constructed buildings in good repair would not experience serious damage from the booms, the publication adds. Even superficial damage is unlikely. The superficial damage reported is largely associated with what is called "stress concentrations"—dehydration, settling, poor workmanship, etc.

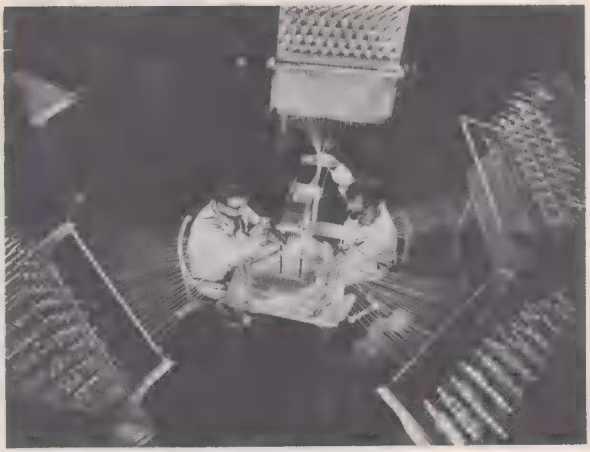
Not all complaints of damage are amenable to logic. Reports of sonic booms have been received when scheduled supersonic flights have been cancelled. Booms have been blamed for happenings ranging from the breaking of a brassiere strap to the shrinkage of furniture.

An orphaned foal is adopted

A three-month-old foal is orphaned and must be fed artificially. This often results in death. To get motherless foals and foaless mares together, a horsebreeder has come up with a thus far successful solution. Mares often smell their progeny, so the horsebreeder tried giving an orphaned foal the smell of a mare's real offspring by putting the dried fur of her dead foal over it. It worked. After several feedings, the fur was removed.

—BIPS

A mare investigates a new foal (right) and recognizes the smell of her own (actually the dried fur of her dead foal tied to the orphaned one.) After some hesitation, she decides everything is all right (below), and lets the foal eat as if it were her own.



SCIENCE DIGEST SPECIAL

Fibers that make everything stronger

Thread-like fibers can be woven together today to produce lightweight, yet extremely strong materials — embarking man on what some scientists are calling the Age of Fibers.

by Arthur S. Freese

WITHIN the foreseeable future, a new world of materials will make it possible for you to own a car as big and luxurious as a Lincoln but lighter than a Volkswagen. You'll be working in buildings five times the height of the Empire State and crossing bridges twice the length of the Verrazano-Narrows. Your doctor will be able to look into your heart and blood vessels without surgery. Supermagnets will protect our astronauts from the dangers of cosmic rays in space and harness the power of the H-bomb for daily living.

This new class of materials is saving the lives of our men in Vietnam and our policemen in New York City. These substances are

being used to make plastic, often disposable, bazooka tubes and other infantry weapons. They fight on Vietnamese waters and increase the life of your tires by over 50 percent. Utilizing these materials, light is piped around corners and into patients' stomachs to photograph the organ in both color and black-and-white. These substances are also widely used in "inner space," the world beneath the seas. On Nov. 9, 1967, an unmanned Apollo Command Module, after an 11,000-mile space trip, slammed back into our atmosphere at 36,000 feet per second. Yet the vehicle was adequately protected from 5,500°F. by a thickness of only 2 inches of heat shield fabricated from these new materials.

In 1964, General Bernard F. Schriever, Commander Air Force Systems Command, said of these new substances: "In the new materials area . . . we are now on the threshold of the greatest single advance that has been made in the last 3,000 years." Since he said this, we have crossed the sill into this new world of fibers.

Nature's secret of strength is the embedding of lightweight strong flexible fibers in a stiff matrix, to gain the best of both worlds: your own muscle and bone are made this way. The Egyptians, 3,000 years ago, were unaware they were applying the same principle when they used straw in their bricks. Bamboo is an excellent example: its long parallel cellulose fibers running lengthwise in the thin matrix give it such strength, lightness and flexibility that a two-ounce fishing rod of this wood can land a three-pound fighting trout.

So important has materials technology always been that the stages of civilization are named for their major new materials—first the Stone Age, then the Bronze, Iron, and finally the Steel. Many scientists believe we are now entering the Age of Fibers. This new world will see a revolution in materials—ultra-high-strength lightweight fibers with high temperature resistance will be embedded in a matrix of plastic or metal to produce compositions distinctly different from their individual components. It has been estimated that, in the 5,000 years since the start of the Bronze Age, the ratio of strength to weight in materials has about doubled—new fiber composites can triple this ratio in one decade.

Fibers in ancient days

Thousands of years ago, desert nomads produced the first fibers when they poked a stick through the molten sand under their fire, and drew out filaments of glass. In 1893, at the World's Fair in Chicago, the "hootchie-kootchie" dance of "Little Egypt" was performed in the first glass dress. Those who rushed to see were disappointed—the dress was opaque, stiff, ugly. But this was the forerunner of fiber glass. In the early 1940s, our Army Engineers developed methods of embedding a cloth of glass fila-

FIBER GLASS FROM FIRE TO WATER

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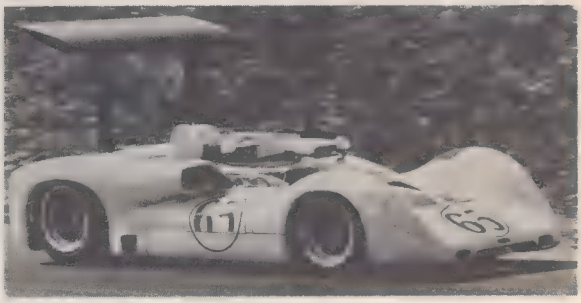

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Fiber glass is used in thousands of products. 1. Fireman wears fiber glass suit which protects him in heat up to 1,600°. 2. Fiber glass racing car. 3. Cal-40 Thunderbird, 40-foot fiber glass yacht. 4. Champion skier Jean-Claude Killy with fiber glass, wood composite skis. 5. Habitat bath—all fiber glass.

4

5

ments in plastic resin—what we know as fiber glass.

Scientists have long known that in fibrous form, many materials are much stronger than in bulk. Even 50 years ago, crystallographers knew enough about atomic structure to calculate that the tensile strength of various ceramic substances was, theoretically, almost a dozen times that of the strongest steel. But the materials never

showed this much muscle in actual tests.

When the reason for this discrepancy was finally tracked down, it proved surprisingly simple. You can't tear heavy celluloid with your fingers; but put a small nick in it and it rips easily. In the same way, any flaw in these ceramics reduces their tensile strength, and in bulk they virtually always have defects. In fibrous form, the decreased size and surface area sharply reduce cracks and the material approaches its theoretical strength.

The fiber composite consists of matrix and fiber, each important in its own way. The ideal fiber should be strong, stiff, light, temperature resistant and reasonably priced, at least in terms of savings effected. Engineers are said to feel that building a 707's landing-gear assembly in solid gold would be a bargain if this would just cut its weight in half. Right now, fibers cost all the way from less than a dollar a pound for some glass filaments up to $12,000 for a pound of sapphire whiskers, and more for others.

The matrix must be plastic and adhesive—one scientist compared the way it holds fibers to the way soft deep mud grips your leg when you step into it. The material must not scratch the filaments or react with them; yet it must bond to them so they can't pull out. The matrix must also distribute the stresses and be able to hold the fibers if they fracture: plastics, aluminum, nickel, copper, beryllium and titanium are all used. To describe a fiber-reinforced composite, three things must be specified—the matrix, the filaments and the fiber orientation.

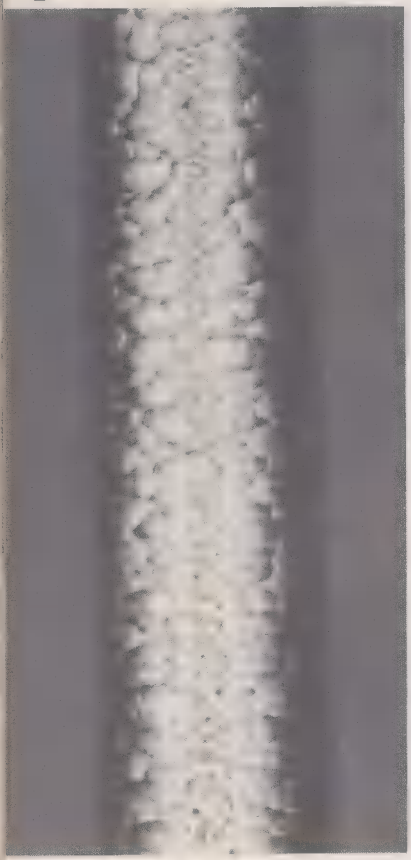
Composites with all their fibers running in the same direction have strength in only one plane (the long axis of the filaments)—this is known as "anisotropy." When you split a board while driving a nail, you experience the weakness of a unidirectional composite—straight-grained wood is the most common fiber-reinforced material. If alternate layers of unidirectional fibrous material are assembled at right angles to each other, you have a bidirectional composite with strength in two directions. If layers are combined in three directions, at 60° to each other, you have "pseudoisotropy". "Isotropy" is where the properties are the same in all directions, as in plywood where thin weak layers of straight-grained wood are combined with their grains or filaments at different angles to give a strong material.

50,000 fiber glass products

Glass fibers are embedded in plastic to form the well-known fiber glass (spelled Fiberglas, it is a registered trade name), more than three-quarters of which have polyester matrices; epoxy resin is usually selected for high performance. This composite is used in nearly 50,000 different products: hammers, fishing rods, golf clubs, boats, skis, your car and its tires.

BORON AND SAPPHIRE FIBER

1



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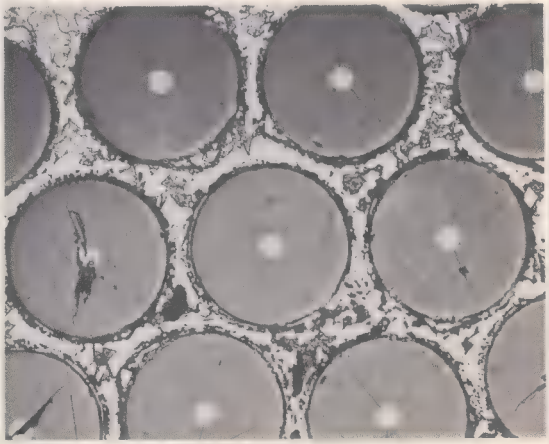

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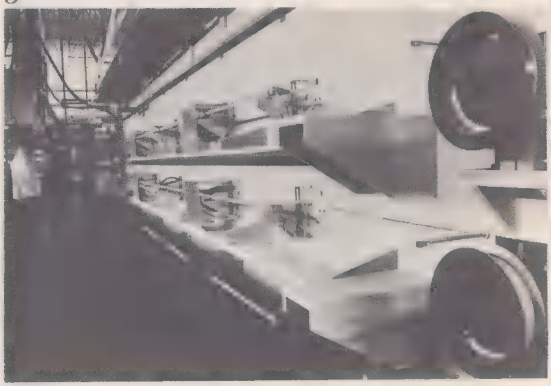


4

Boron filaments and fibers are among the farthest advanced and among the best in strength, stiffness and weight. Sapphire filaments and whiskers will mean razor blades that will last a lifetime. 1. The surface view of boron filament enlarged 500 times. 2. A cross section of boron filament, enlarged 750 times. Here it is embedded in aluminum. 3. Boron production plant. Filament-producing lines are mounted vertically on wall with power and feed at far end. 4. Sapphire filaments are about thickness of human hair. Single crystal sapphires grow in variety of shapes, as shown.

Glass fibers, nearly as fine as a human hair, are used to transmit light—even plastic filaments such as Du Pont's "Crofon" serve. Coiled, twisted, even knotted, the filaments pipe light from a source at one end, just as a garden hose carries water when the valve is opened. Swallowed, the fibers make it possible for doctors to light and see into the stomach—and even photograph it. Filaments have been passed through an artery or vein of experimental animals until they reach the heart—both the interior of this organ and of the great blood vessels can be seen and photographed without operating on them. A dozen or so automobile dashboard light bulbs can be replaced with a tiny bundle of fibers, and as many as 30 separate points can be lighted from one source. This technique will soon be used in everything from vending machines to detection devices, from children's toys to electronic equipment; even business machines and the Bendix Corporation's "moon buggy".

Fiber glass serves as a reentry heat shield (as in the Apollo spacecraft), and in the survival kits of spacewalking astronauts, their space suits, even their attitude guns for maneuvering. It also goes to war in our missiles such as the Polaris and Minuteman. Our airmen and soldiers are protected by fiber glass-reinforced armor. Rocket launchers are made of it, and the Navy uses fiber glass river patrol boats on Vietnamese waters. It also goes beneath the seas as the outer skin of deep-diving submersibles and the superstructure of submarines. Its weaknesses lie in its limited stiffness, and that it can only be used in a plastic matrix.

Other fiber-reinforced-plastic (FRP) is now being tested in such aircraft as the F-111, the Bronco COIN and the Navy's T-2B trainer. Weight savings as high as 550 pounds have been predicted for the F-111's tail section, by using a boron FRP instead of aluminum. Almost unlimited fatigue life, better performance after bullet damage and more design freedom are seen for the helicopter rotor-blade section made of boron FRP.

New world of filaments

This new world is coming on so fast that a recent article listed 29 fibrous materials only 15 of which are yet available commercially. Only three filaments can be considered close to the ideal.

Filaments are made in various ways. Glass fibers are still drawn, essentially just as the desert nomads unknowingly did thousands of years ago. Burning up an organic fiber such as viscose rayon leaves a carbon filament. Fibers are also made by crystal growth and by deposition. A good example is boron—an ultrafine wire of tungsten, at red heat, is pulled through a chamber with boron trichloride and hydrogen gas. Pure boron is deposited on the moving wire; the final filament is 95 percent pure boron and 5 percent tungsten core.

Boron filaments, made on a tungsten core, are the farthest advanced. They have stirred many dreams—building ultralong bridges and superhigh buildings, halving the weight of hydrofoil ships and air-cushion trains. Boron fibers are among the best in strength, stiffness and weight. Boron-epoxy FRP is as strong and stiff as high-strength aircraft steel but 75 percent lighter. Boron filaments, built on a tungsten wire core, are six times stiffer than glass fibers, but much more expensive.

However, in aerospace one must consider what L. Brian Keller, head of the Plastics Section of Hughes Aircraft's Materials Technology Department, has said: "Each pound of weight saved is worth in the order of $15,000 to $20,000." And then, speaking of composites in general: "I would anticipate we can see weight reductions in an airplane up to 30 percent by using these materials." Commercial applications must await price reduction, even though boron can also be embedded successfully in metals which can stand more heat than plastics. Boron FRP are anisotropic, but have been combined in as many as 50 layers. A 32-layer piece would be 1/6 of an inch thick and equal in strength to commercial building

Terms used in the Age of Fibers

Fiber—fine thread-like pieces of various materials. This is an overall term which includes filaments, strands, yarns, whiskers and eutectics.

Filaments—a long continuous fiber.

Strand—a bunch of filaments.

Yarn—a twisted strand (2 strands is a 2-ply yarn).

Whisker — short "toothpick," pure single crystal (grown, not drawn).

Eutectic — an alloy composite which, after melting, separates into whiskers and matrix on solidifying.

Matrix—the body of the material holding the fibers.

Composite — actually, anything made up of two or more different materials; but, in this article, limited to fiber-reinforced materials.

FRP—fiber-reinforced-plastic.

Ceramic—a combination of one or more metals with a nonmetallic element, usually oxygen. These compounds are highly resistant to most chemicals.

Tensile strength — a measurement of the resistance of a material to being pulled apart.

Modulus of elasticity—this is a ratio: the higher the modulus, the stiffer the material.

Whiskers, tiny single crystals, are enormously strong — some 10 times as strong as strongest steels.

steel five times its thickness.

Carbon and graphite fibers, next to boron the most-likely-to-succeed, are weight for weight the strongest and stiffest filaments made. These are made only in yarn form, and their applications will be the same as boron's. As a composite fabric with glass fibers, they have heated the seats in the 1966 Cadillac.

The next most important fiber is silicon carbide, made like boron on a tungsten wire. It is close to boron in its mechanical properties, but some 20 percent heavier, and engineers foresee its use in the same general areas.

Stainless steel is also being made in filament form. It's being used in carpets so that you won't get shocked when you walk across these rugs and then touch some metal. The steel is easily blended with the fabric in the standard carpetmaking equipment. Hotels and institutions will no longer have to dose their carpets with antistatic agents every month. This fiber could also prevent clothes from clinging.

"Whiskers" are tiny single crystals and these are the strongest. Some are 10 times as strong as the strongest steels, and they vary in length from half the thickness of a human hair up to an inch (boron filaments three miles long are now being routinely produced). A whisker's thickness may be as little as $\frac{1}{20}$ that of a human hair. Sapphire and silicon carbide whiskers are the most popular. Incorporated in either metal or plastic, the potential of this form is enormous.

The latest development is the production of this same sapphire as a filament. Dr. A. I. Mlavsky, vice-president of Tyco Laboratories Inc. of Waltham, Mass., summarizes its use: "It opens the door to unique employment of composite materials in a wide variety of critical military, industrial and research applications." This new process opens the way to sapphire razor blades which could last a lifetime.

New technique used

A new technique makes both fiber and matrix at the same time by the controlled melting of certain metal alloys. In these eutectics (from the Greek word meaning "easily melted"), an alloy composition is melted: as it solidifies, one of the materials forms whiskers and the other acts as a matrix. The result is a composite of great strength and heat resistance.

To produce an isotropic composite, Avco Corporation has developed a three-dimensional reinforcement material — their "3-D" process. Two sets of filaments are woven at right angles to each other in the horizontal plane, and then

a third set is added in the vertical plane at right angles to the other two. The vertical fibers are separated from each other by a distance no greater than the diameter of the horizontal fibers. Thus there is friction between the filaments to provide a binding force that maintains fabric integrity as the composite is removed from the loom.

This material can be made with one or a combination of several filaments — glass, boron, carbon, quartz, graphite or nylon. Resin is then vacuum-impregnated around the fibers and then cured. This 3-D composite boosts interlaminar strength as much as 15 times, and the material can be designed for specific uses.

Avco has also encased filaments of niobium-titanium in high purity copper to build a superconducting magnet which may open the way to control the power of the H-bomb and its use for peaceful purposes, such as powering spacecraft on months-long journeys far beyond the moon. These magnets would guard the astronauts from the cosmic rays and generate electricity for our use here on earth.

Now, at the birth of the Age of Fibers, no scientist is willing to predict the future of this new materials technology. The closest thing to a forecast was a comment by Keller: "Twenty-five years ago, there was no such thing as a structural fiber glass composite. Now many millions of pounds are used annually. We can expect the same kind of expansion in the high-performance composites."

Perhaps the vast possibilities even leave the scientist speechless.

MATERIAL	FORM	TENSILE STRENGTH (in thousands)	MODULUS OF ELASTICITY (in millions)	USES
GLASS E-type	filaments	500	10.5	Consumer products, outer space, military, aviation, inner space, industry and agriculture.
S-type	filaments	650	12.6	
Boron	filaments	400	55	Outer space, aviation military, industry, construction.
Carbon-graphite	filaments	320	62	Same as boron, but may be superior.
	whiskers*	2,845	170	
Silicon carbide	filaments	300	67	Same as boron.
	whiskers	3,000	70	
Boron nitride	filaments	200	18.8	Same as boron.
Tungsten	filaments	580	59	In general, similar to boron.
Molybdenum	filaments	320	52	
Steel	filaments	600	29	Antistatic uses in carpets.
Beryllium	filaments	185	35	
Sapphire	filaments	300 (to 2,000)	25 (to 70)	Same as boron but special optic uses.
	whiskers	3,000	62	Razor blades with lifetime edge.
Silicon nitride	whiskers	2,000	55	
Iron*	whiskers	1,900	29	

*There are many more substances being used in filament research, but those listed here (with the exception of iron and graphite whiskers) are commercially available.

Significance of these new developments to industry, business and professions

• *Agriculture*—Fiber glass FRP reduces maintenance costs on pipes, tanks and silos for a range of corrosive liquids and solids, including fertilizers. This FRP is air-tight, corrosion-resistant, immune to dry-rot and rust.

• *Automotive*—Fiber glass FRP uses are expected to increase from 110 million pounds used in 1967 to 784 million by 1970. Besides forming many components, this material is also used for rust-proof auto bodies and underbodies, and it is increasing tire life by 50 percent.

• *Aviation and outer space*—The second generation ultra-strong and ultra-lightweight fiber composites such as boron and graphite are revolutionizing the field. An all-composite plane is just one of the changes which are foreseen for the next few years. Aircraft components of fiber glass FRP will increase at 15 to 20 percent a year.

• *Consumer goods*—In 1967, fiber glass was expected to replace some 61 million pounds of metal products in such items as golf clubs, skis, fishing rods, camping trailers, seating and assorted tools.

• *Construction*—When the second generation fiber materials become feasible pricewise, buildings will shoot skyhigh, bridges will stretch. Architecture will find new dimensions.

• *Inner space*—A number of deep-diving submersibles have outer skins of fiber glass FRP, as does the superstructure of submarines.

• *Marine*—Fiber glass is used for some 75 percent of outboard boat hulls, but the new field is in commercial and fishing boats, now being built up to 84 feet. Marine engineers see 300 foot ships of this composite.

• *Medicine*—Glass and plastic filaments can help doctors see deep inside the body without surgery, through fiber optics.

• *Military*—Fiber glass composites are replacing metal in ordnance applications, as barrels, tubes and breech mechanisms, missiles, in aircraft and personnel ballistic armor.

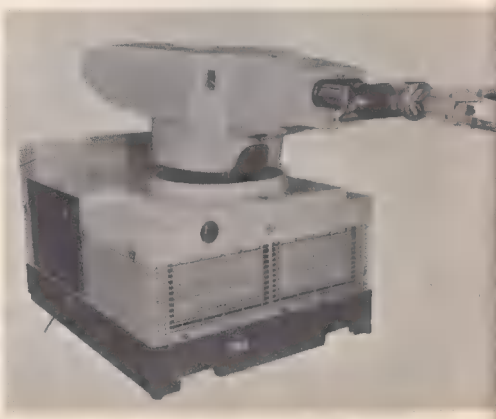
• *Optics*—The new technology of fiber optics has opened new worlds of light. Light can be brought into hard-to-get-at places without bulbs or electrical outlets. The possibilities can only be guessed at—communications equipment, advertising, electronic controls, aircraft, voting machines—you name it.

NEW FOR INDUSTRY

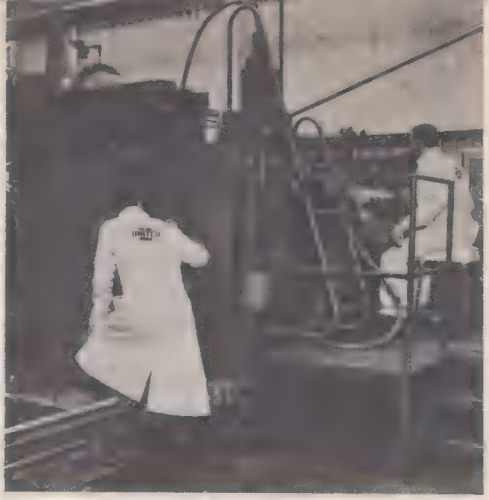
This half-ton ingot of tantalum/tungsten/hafnium, one of the largest ever produced, will be used in fabrication of aerospace nuclear parts for Atomics International, as part of an Atomic Energy Commission program. From National Research Corporation, a subsidiary of Norton Co., 160 Charlemont Street, Newton, Mass.

World's first portable neutron television system shown here has been developed by the Central Research Laboratory of Tokyo Shibaura Electric Co., Ltd. (Toshiba). System features standard TV receiver, small-sized accelerator and multi-stage image intensifier. Components, from left, image intensifier, moderator, accelerator tube.

New on the production line at several Ford Motor Co. plants is Unimate, an automated machine with magnetic memory and hydraulically operated muscle power. Made by Unimation, Inc., Danbury, Conn. Unimate can lift 500 instrument panels and place them in a press each hour. It follows positional instructions recorded in its magnetic memory during training period, which requires neither programmer nor special tapes; instead a hand-held control box that simply plugs into the machine.



The "world's largest outboard motor," 20 feet from top to bottom, will be used for special steering problems in the lead barge of a large river barge tow, consisting of a group of barges lashed together. Power unit is remote controlled. By Stewart & Stevenson, Houston, Texas.



This electron beam welder is the first of its kind to be used by an air carrier, United Air Lines, to repair jet engine components. By Hamilton Standard Division of United Aircraft Corp., Windsor Locks, Conn., the machine is X ray shielded.

Stanford University professor, Dr. Norman H. Crawford, has developed computer program capable of simulating any river system. ▶ From here, he hopes to develop river management system. Computer by IBM, 112 East Post Road, White Plains, N. Y.

MEDICINE

New combat for old enemy—tooth decay

A new enzyme designed to control tooth decay is being tried in patients after animal studies at the National Institute of Dental Research have shown promise. If human trials are successful, the material might be used by the general public in toothpaste, mouthwash, drinking water or even incorporated in candy.

The enzyme is called dextranase. It works in animals by dissolving a

sticky plaque that forms on the teeth and enables decay-producing bacteria to cling there.

An editorial in the *Journal of the American Dental Association* said dextranase "may well be a major breakthrough in the control of dental caries."

Dr. Robert J. Fitzgerald and Dr. Paul H. Keyes of NIDR inoculated newly-weaned hamsters with streptococci bacteria, known to be involved in tooth decay in animals. The animals were fed a diet with a high sugar content. After 10 days, some of these animals were given dextranase. Within a few days, the sticky plaque that had formed on their teeth began to disappear. At the end of the experiment, dental caries were absent or drastically reduced in these animals as compared to a group of hamsters given streptococci and a high sugar diet but no dextranase.

The plaque, if not removed, may harden into calculus or tartar that can lead to gum disease. It is significant that some of the untreated animals had bone loose under the gums.

It is the first time a compound has been developed that has potential for simultaneously fighting decay and gum disease. Gum, or periodontal disease, is the primary cause of tooth loss in adults.

Only a small amount of dextranase, produced by Merck Sharp and Dohme Research Laboratories, was available for the animal studies, but experimenters said the results were so striking no further animal studies were needed.

Even if successful, dextranase will not help all patients, because plaques may be formed by oral bacteria other than streptococci.

Dental caries, one of the most common diseases, afflicts 98 percent

of all Americans at some time in their lives. The cost of treating dental caries is estimated at more than $1 billion a year, accounting for about 5 percent of all family expenditures for health services in the U.S.

Today, through laboratory and clinical research, many of the conditions associated with tooth decay are better understood. Certain types of bacteria found in the mouth are known to contribute to the formation of deposits which stick to tooth surfaces. These deposits are collectively known as dental plaques, but they may differ in the types of microbes present and in their effects on oral health.

When highly soluble and fermentable foods, such as sugar, are metabolized by bacteria within one type of plaque, acids are formed. These acids may dissolve the enamel of the tooth and lead to dental caries.

Get out of bed

Patients put on a regimen of prolonged bed rest often gain little more than a whole new set of complications, contends Dr. David Shuman, Philadelphia osteopathic physician. Patients who are put on their feet as quickly as possible recover faster and have fewer side effects.

Bed rest is at times necessary, he points out, but usually it should be measured in hours rather than days or weeks. Even in cases of serious injury, only the affected parts of the body usually need be immobilized.

Dr. Shuman decries the indiscriminate use of bed rest as a treatment fad not much different from blood-letting in the early days of medicine. Patients confined to their bed for long periods are prone to a poor mental outlook and to developing physical side effects, including kidney stones, bed sores, lung clots or pneumonia.

"Happily, there is a growing body of experience to support the advantages of ambulation," says Dr. Shuman. "Patients prefer to make this personal effort over the idea of invalidism and decay commonly associated with bed confinement. Properly advised, patients will gladly settle for crutches, including an occasional twinge and a bit of fatigue easily remedied by a very short rest."

Aerosols agitate asthma

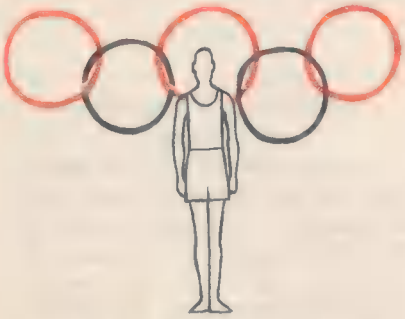
Use of hand atomizers to administer asthma medicine can trigger an attack of asthma, warns Dr. John F. Keighley of Syracuse. He cites four cases in which an asthma attack developed after the patients had breathed aerosols containing a drug used to dilate blood vessels and passageways in the respiratory

tract. Asthmatic attacks also have been produced in four other patients using aerosols of adrenalin, a drug used to constrict blood vessels and respiratory passages.

Dr. Keighley, chief of the pulmonary disease section, Veterans Administration, Syracuse, said atomizers have been used widely since World War II for spraying tiny particles of drugs into the breathing tracts. When used properly and not to excess, the aerosol medicine can be an effective reliever of congestion brought on by asthmatic attacks. But too-frequent use can irritate the muscular surfaces of the respiratory tract, surfaces that are already irritated by recurring asthma.

Olympic worry

Coaches are concerned about their athletes developing travelers' gastroenteritis, more commonly re-



ferred to as "turista," while in Mexico for the Olympic Games later this year. In general, younger and more inexperienced travelers are the most likely victims. One investigator estimated that one-fourth to one-third of U.S. travelers to Mexico's interior develop the ailment within the first several weeks of their stay.

Dr. Eduardo Hay of Mexico City says every effort is being made to protect the health of the athletes. Maintenance of high levels of personal and environmental sanitation is the key, he believes. Persons with poor personal hygiene habits are particularly susceptible.

Bonus from ulcer treatment

A case of peptic ulcer isn't all bad. A drug widely used by physicians in ulcer treatment has been found to protect against a hazardous element in radioactive fallout.

The antacid drug, aluminum phosphate gel, blocks the absorption of radioactive strontium in man, medical scientists at the Hines Veterans Administration Hospital in Chicago have found.

Strontium presents a long-term threat in radioactive fallout from atomic bomb tests. Only half of it decays in 28 years. It falls onto the surface of plants and soil and gets into man through milk, butter, flour, cereals, fruits and vegetables. Strontium mimics calcium in the body and becomes concentrated in bones and teeth. However, there is no direct evidence a hazardous amount of strontium has accumulated as yet in bones of Americans.

Doctors at the VA found when aluminum phosphate gel is given to volunteers just before they receive a tracer dose of radioactive strontium, only 87 percent of the toxic material is absorbed.

There also was some evidence the gel is effective even when given after the strontium is taken.

The test material used, strontium-85—is a sister element of strontium-90, the hazardous product of nuclear reactions. The strontium-85 is harmless at the dose administered.

"The discovery of strontium absorption inhibition by aluminum phosphate gel would prove most useful in protecting human health against a rise in strontium-90 levels," says James G. Terrill Jr., director of the National Center for Radiological Health. "Aluminum phosphate could be made immediately available."

Available for many years to ulcer victims, it now proves a bonus in their treatment.

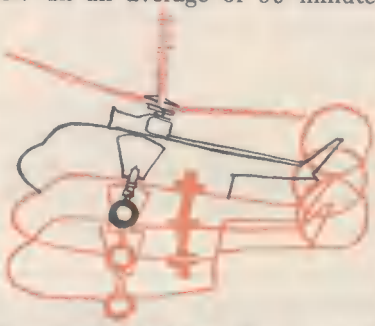
Safer in Vietnam

Lessons can be learned at home from medical experience in handling the wounded in Vietnam.

Dr. Wayne O. Southwick says it is safer to be wounded in Vietnam than to have an accident on U. S. highways. Survival rate is much greater on the war front than on the home front.

"The war in Vietnam will end one day, but there is no end in sight for the trauma epidemic at home," Dr. Southwick says. "We should be able to give the same first aid, evacuation and surgery to the casualties at home that we do to the wounded in Vietnam."

Key to the battle front success is the rapid evacuation by helicopter. In an average of 35 minutes



from the time of wounding, the patient is in a base hospital.

Mortality from wounds in Vietnam is 1 percent, compared with 3 percent in Korea and 8 percent in World War II.

Since returning from the battle zone, Dr. Southwick has been working on a program at Yale to improve accident care. One system under study is television transmission of the accident scene to the hospital emergency room so surgeons can advise ambulance attendants on handling of victims.

Whiplash injury is real

The whiplash victim, labeled by some doctors as neurotic and by

some trial lawyers as a malingerer, may indeed have severe injury and real pain, says Dr. Jack Wickstrom of New Orleans. He has become convinced that pathological changes do occur, after a microscopic study of tissues of test animals, including rabbits and monkeys. The animals suffered damaged neck cartilage and muscle and even some destruction of brain cells. None of the changes were apparent except in postmortem examination.

Many doctors disparage whiplash as an injury because there usually is no visible damage clinically or under X-ray. They advise wearers of rubber collar supports that the pain is but a product of their imagination.

"The damage can be real and the pain can be real," says Dr. Wickstrom, professor and chairman of the department of orthopedic surgery, Tulane University.

He explained that when the head is flung forward it passes through a natural range of motion, stopping when the head strikes the breast bone. But in the return snap, there is nothing to stop the head until it reaches the shoulder blades. The front muscles and ligaments are stretched and torn.

AMA's facts about medical tradition

Many of our misconceptions about health stem from tradition laid down by our ancestors, settlers who were remote from civilization and came up with their own medical lore. Often much of what they did was more harmful than beneficial.

The American Medical Association's health information manual, Today's Health Guide, lists the facts about some of these misconceptions that have lasted until today.

- Blood pressure of 100 plus an individual's age is *not* the normal value.
- Red meats and alcohol are not necessarily harmful to persons with high blood pressure.
- Fish is not a brain food. It is merely a nutritious food for all parts of the body.
- Sweets, while possibly detrimental to the teeth, are not the sole cause of tooth decay.
- There is no health reason why shellfish and ice cream cannot be eaten at the same time, as long as neither is spoiled.
- Gargles and mouthwashes do *not* kill germs in the mouth or throat.
- Boils are not due to impure blood.
- Punctures from rusty nails are no more dangerous than punctures from shiny nails, because the danger is in the germs that either wound may allow in the body.

The meal that glows in the dark

At Princeton University, a pair of scientists recently concocted an unusual seafood dinner. Then, instead of eating it, Dr. Frank H. Johnson and Dr. Osamu Shimomura turned off the lights in the room. The meal glowed in the dark so brightly that they photographed it by its own light.

The glowing meal of whiting, shrimp, crab and wine had been treated with chemicals extracted from bioluminescent organisms. These creatures make their own light in a way that man still does not understand. In the last 10 years, however, he has learned how to extract the light-producing materials.

To make their seafood dinner glow, Drs. Johnson and Shimomura poured a few drops of the extract of a harmless bacteria on the fish. They added a few drops of a chemical extracted from a minute shellfish to the wine.

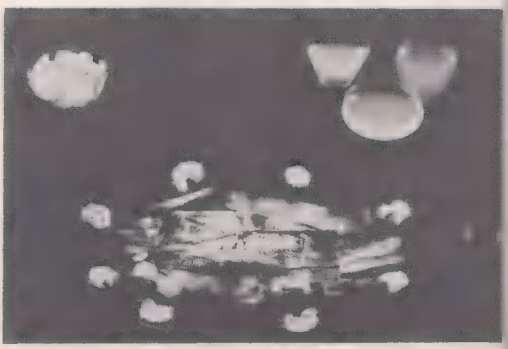
Almost a hundred years of painstaking research made the Princeton meal possible. A Frenchman, Raphael DuBois, was the first to discover that one kind of bioluminescence is due to two kinds of materials. He drew off impure extracts of the substances and called one "luciferin" and the other "luciferase."

Investigating further, the pioneering Frenchman found that it was luciferin that provides the light through its reaction with oxygen in water, while luciferase is the catalyst whose presence is needed to complete the reaction.

In 1916, a Princeton faculty member, Dr. E. Newton Harvey, be-

A dinner treated with chemicals extracted from bioluminescent organisms is shown, photographed in normally-lighted room; below, it is photographed by its own light.

Dr. Frank H. Johnson and Dr. Osamu Shimomura



A flask of purified Cypridina luciferin and luciferase illuminates Dr. Frank H. Johnson, professor of biology at Princeton.

came fascinated with the luciferin-luciferase reaction. He began a 50-year series of experiments on the sea firefly, *Cypridina,* the creature whose extract was used to make the wine glow in Dr. Johnson's and Dr. Shimomura's dinner.

In spite of his efforts, Harvey did not succeed in extracting the pure light-producing materials from tiny shellfish. But his former pupil, Dr. William D. McElroy, did the trick with fireflies in 1956 and 1957 at Johns Hopkins University. And four Japanese scientists, one of them Dr. Shimomura, crystallized *Cypridina* luciferin in 1957.

A few years later, Drs. Johnson and Shimomura, both now working at Princeton, discovered an entirely different kind of bioluminescence in the luminous jellyfish called *Quequorea.* The creature secreted a kind of "photoprotein" that glows when it reacts to various chemicals in water. The two investigators succeeded in crystallizing the photoprotein of the jellyfish and later of the marine paddleworm.

Crystallizing the light-producing substances of tiny, fragile creatures like the jellyfish and the paddleworm was no easy matter for the scientists. To obtain 10 millograms —slightly less than 3/10,000 of an ounce—of photoprotein, the Princeton scientists processed some 20,000 jellyfish. The paddleworm projects required some 10,000 worms.

The jellyfish were particularly difficult to work with. So delicate they had to be caught by hand nets, the tiny creatures were cut in strips with hand scissors and squeezed through a handkerchief. The "squeezate" was then shipped to Princeton on ice for further purification.

Research into the phenomenon of bioluminescence is a prime example of "pure research" intended to increase man's knowledge of the field without regard to any practical application. Ironically, however, this purest of pure research may soon provide valuable aid to the most intense "applied" research effort of our times—space exploration.

Scientists are now talking about using a luminescence system such as that of the sea firefly to detect contamination of the atmosphere inside space vehicles by jet fuels. Jet

fuel temporarily poisons the luciferin-luciferase reaction, dimming the light produced. When the fuel is eliminated, the light soon recovers its brightness.

The same kind of system might well be used to measure the pollution of the air we breathe on earth, some scientists believe.

Another use being considered for bioluminescence involves firefly extract. Life's energy-giving chemical, adenosine triphosphate, or ATP, can switch on the light of the extract, so the substance might well serve as a test for life on other planets. An automated laboratory based on another planet could test planetary soil samples with firefly extract.

A more down-to-earth application of bioluminescence is already undergoing tests. Since the photoprotein discovered by the Princeton investigators in the jellyfish and paddleworm reacts to iron or calcium, the chemical should detect the same materials in blood or milk. Medical laboratories are now making efforts to use the test for calcium to study the fundamental process of muscle contraction.

Although progress in bioluminescence research has been rapid in recent years, much still remains to be learned about the mysterious process. "Even in the most thoroughly studied system, the firefly, no satisfying answer can yet be given to the seemingly simple, innocent question, 'How does it flash?' ", notes Dr. Johnson.

Scientists question, too, why many of the hundreds of organisms capable of bioluminescence produce the effect. Fireflies and certain sea worms do use their light as a signalling device in mating, and deep-sea fish may use it to lure prey, but what good is bioluminescence to a fungus growing on a rotten log?

To answer these and other questions about the fascinating phenomenon of bioluminescence, research continues on the creatures who can do something no warm-blooded animal can: produce their own light.

Idea of the Month

The flash that won't quit

MARTIN S. Ackerman's Perma-Cube was put on the market four months before the patent for it was issued, and in that period brought his company more than $750,000 at wholesale. The profitable item is a permanent camera flash unit, designed as successor to the rotating cube, which gives four flashes and no more.

At age 35, the inventor, shown with his invention, is president of Perfect Film & Chemical Corporation, which distributes his Perma-Cube from Manhasset, L. I.

The unit comes in two forms. The rechargeable Perma-Cube, retailing at about $25, delivers 30 or more flashes before it needs to be plugged into an alternating current outlet.

The battery model, retailing at about $20, will flash up to 100 times before it requires new penlight batteries. Either one can be operated directly from A.C. wall current.

The electronic unit in both synchronizes with the camera shutter. Perma-Cubes are offered for most Kodak Instamatic models and for other cameras equipped to use flash cubes.

Issuance of the patent (3,364,-829) was expedited by the Patent Office because of the market demand for the item. Ackerman invented it in May 1967, and filed his application a few days later.

The inventor, whose hobby has long been photography, got his A.B. from Syracuse University in 1953, and three years later received his law degree from Rutgers, where he was editor of the Rutgers Law Review. He is a partner in the New York law firm of Cooper, Ostrin, DeVarco & Ackerman.

Perfect Film & Chemical Corporation, of which Martin Ackerman has been president and chairman since 1965, was formerly United Whelan Corporation. Its 1967 sales, from its film processing, merchandising and other activities, were about $90,000,000.

—Stacy V. Jones

PIX

A surprising report on the generation gap

Today's college student—rebellious radical who deals in pot, protest marches and promiscuity? No, says a six-year study of over 3,000 students—on the whole, this generation differs very little from its parents.

by Julius Duscha

A surprising picture of today's college generation was drawn in a 666-page report of a six-year study of students at Stanford University and the University of California's Berkeley campus.

The detailed study of the views and activities of more than 3,000 students, conducted by Stanford psychologist Joseph Katz, concluded that:

No more than 10 percent of students were involved in such activities as the civil-rights movement, the New Left, or efforts to reform universities through vehicles like the 1964 Free Speech Movement at Berkeley.

Morals still count

Sexual promiscuity was not widespread and most students still approached sexual matters from a strictly moral point of view.

Few students considered themselves radically different from their parents and most students tended to follow the advice of parents in deciding on their own careers.

The college years were relatively free of struggle and violent change for most students, and for many students college life was a lonely period.

Most students failed to develop strong academic and intellectual interests during their college years, and nearly all students focused their interests merely on getting good grades because this assured their staying in college, often led to scholarships and gained parental approval.

These were among the major findings in the report, which is perhaps the most comprehensive effort yet made to find out whether the present college generation differs significantly from its predecessors.

Although the study indicated that most students today were not as radical in their views and activities as they have been pictured, there was some confirmation that the current college generation is questioning long-established values. The study disclosed, for example, that students opposed the increasingly bureaucratic structures of colleges and universities and that no more than half of the sons of businessmen want to go into business themselves.

The students also said that they admired political figures far more than artists, writers, philosophers or scientists, which was taken as an indication that this was a college generation of doers. And, not unexpectedly, most students said that they felt the happiest time of a person's life was from the ages of 22 to 35, lending emphasis to the youthful chant: "Don't trust anyone over 30."

The views of freshmen who entered Berkeley and Stanford in 1961 and seniors who graduated in 1965 were obtained through lengthy questionnaires and exten-

Of the students questioned, more attend church frequently than participate in protest movements.

sive interviews. The results were tabulated and evaluated over the last two years.

Berkeley has been considered a center of student unrest since the Free Speech Movement, which culminated in a sit-in four years ago; while Stanford is typical of the larger private schools offering a high-quality education.

Parental influence strong

"What in the interviews strikes one about many students is the relative passivity with which they view life," psychologist Katz commented in his report. "The coming to college has for many not been a deliberate choice but a matter of course. When asked what their occupational plans are, students say that their parents leave that choice up to them, yet upon probing it becomes clear that they are strongly influenced by their parents' wishes and aspirations as well as by the prevailing fashions and opportunities in the society.

"By the end of the senior year," Mr. Katz continued, "students are heading towards various graduate schools and professional training. But probing reveals that further schooling is viewed by many as an opportunity for finding stimulation and achieving commitment there. It seems that for many there never will be a clear-cut decision, but that each step, channeled by educational and other social institutions, gradually determines the 'decision' for them."

But the details of students' views and activities were even more interesting than the broad conclusions drawn from the study.

When the researchers asked about extracurricular activities, for instance, from 17 to 25 percent said that they went to church frequently, but only 4 to 7 percent said they were active in the civil-rights movement. A minuscule 2 to 4 percent acknowledged being involved in national or community political activities, and from 4 to 8 percent said they were involved in campus political activities. But these small numbers attract a great deal of attention. Six percent of the men and 12 percent of the women said they sought out offbeat places and people frequently. (The study was completed before the hippie world of nearby San Francisco's Haight-Ashbury district became an attraction for some college students.)

In discussing sex and the college student, the report noted: "Our investigations do not confirm the popular stereotype of widespread sexual promiscuity. Sexual intimacy where it occurs takes place in the context of a relationship that is serious rather than casual. Sexual behavior, in contrast to the

'official' code, allows for premarital intercourse.

"Students' interest in the opposite sex has physical contact only as one component. Establishing more communicative relations often is uppermost on their conscious agenda. We have found that administrative and faculty caretakers of students often do not see the students' search for greater psychological intimacy in the proper perspective when they view student demands as primarily 'sexual' in nature. Our interview experience has also taught us that beneath a layer of 'coolness', the students still carry many anxieties concerning their sexual attitudes and behavior."

Surprising, too, were the findings of the researchers that students tend to move within the same patterns of living as do their parents. "In their activities during the college years," the report noted, "in their values, in their choice of occupation, the vast majority seems to conform to the behavior and expectations of their own original family. Few define themselves as different from their parents and set out to fashion a different life style for themselves. Much of the domination of the family is unconscious and can in some cases go together with conscious hostility to one or both parents."

In commenting on the relative lack of struggle and violent change among college students, the report said that "for most students adaptation to the role-demands of their college environment and to the anticipated future roles in society seems to take place without conscious conflict." This, the report continued, raised a question as to whether students are unaware of their choices or are failing to face up to them.

After noting that few students engaged in reflective thinking or paid much attention to purely intellectual pursuits, the report said that colleges and universities may be favoring in their admission procedures students "whose relation to the world is strongly by way of concepts, and neglect those who relate to the world by way of action, or of feeling, or of involvement with other people."

Because grades are so important

"The Encyclopedia Britannica says you're of minor importance."

"The spark is there . . . and we fail to use it," says psychologist, blaming system for lack of stimulation.

in students' lives, the report continued, students excelled at what they called "psyching out" professors. This involved a careful determination of what a professor wanted on examination papers, "via a study of his previous tests, of his intellectual and emotional preferences and other clues he provides in the classroom."

Author Katz blamed professors and the university system for the failure to stimulate students and commented:

"Even good students expect to be stimulated. But when the academic environment does not provide such stimulation sufficiently and at the same time makes one feel that one ought to be more interested, guilt is inevitable. Not surprisingly, this guilt may be projected onto others. . . . The spark is there early in the freshman year, and we fail to use it."

Although alumni of colleges and universities may take some comfort in the findings of the study that today's students are not as radical and as different as they have been generally pictured, author Katz found the results disturbing for other reasons.

In summarizing his report Mr. Katz noted that many students failed to put together the academic-intellectual offering of colleges and universities with their own motivations and plans.

"Many students," Mr. Katz added, "do not learn adequately to connect their reasoning capacities with problems they face in their own development. Major life decisions such as occupational or marital choices, as well as minor ones, are made without sufficient utilization of the perspective which intellect and awareness can bring. The consistent encouragement of abstract thinking, at the expense of more exposure to experience and bringing into the open of deeply felt emotions, leaves the student with insufficient practice in the art and science of applying thought to the clarification of feelings and to decision-making."

Disappointments for many

And college life remained full of disappointments, as this excerpt from an interview with a girl showed:

"I was going to be a doer, an emancipated woman . . . I was going to be an intellectual and I was going to do something really important. . . . I finally realized that I'm not an intellectual. I don't want to be somebody like assistant secretary of state, or be in the President's Cabinet, and I do want to be a homebody. I think it will be fun. Daddy may look at me with disgust—'There she goes . . . into the rut—count her out.'"

Association for the Help of Retarded Children

The psychological impact of the retarded child

by Flora Rheta Schreiber and Melvin Herman

A couple wanted a second child, but was afraid to have one. Two brilliant teenagers wanted to go to college, but couldn't. A 16-year-old boy tried to get his brother on his baseball team, but the team laughed at him.

Each of these incidents had the same cause—mental retardation in the family. The couple was afraid because their first child was men-

tally retarded. The teenagers could not afford college because their widowed mother, in a futile search for a cure for her mentally retarded son, had used up the $100,000 estate her husband had left. The team laughed because the 16-year-old, eager to include his retarded brother in his own circle of friends, had over-reached himself.

A retarded child in the family profoundly affects the lives of all other family members.

Family stresses are great

The influence goes far beyond just learning how to get along with and treat the child. After discovering that he is retarded, the parents find that the stresses they experienced before are now magnified. "How a particular family makes its own adjustment," says Pauline C. Cohen, a social case worker, "is related to its customary pattern of meeting stress."

Many parents, obsessed by "Why did it happen to me?", arrive at irrational explanations. One father seriously believed that his daughter was retarded because as a boy he had been jealous of a sister after whom the child was named. The father became obsessed with the thought that he was being punished through the child. It took psychotherapy to release him from his obsession. Many parents when confronted with a retarded child have to resort to some type of psychiatric help.

The anguish of having a retarded child often evokes intense religious conflicts. "To face the fact," one mother said, "that your child is a mental cripple and will remain so throughout life—well, this simply places us outside the providence of God's mercy and justice, or so we often feel—if we can indeed still believe that there IS a God. If we have been reared in a somewhat puritanical tradition, we may become so overwhelmed with a sense of guilt that it is totally impossible for us to see our problems from a rational point of view."

Relationships with friends and neighbors often become difficult. A parent who refuses to admit that the child is retarded must carry the double burden of grief and pretence. But even the parents who can and do admit their child's handicap often find it almost impossible to share their sorrow because friends, neighbors and even relatives hesitate to ask about the child. "In the case of severe physical illness or death," one mother said, "we would think it inconceivable if our friends, relatives or neighbors showed no concern for our need—yet in this case, where the emotional shock is sometimes even more severe than in death, we are denied the privilege of sharing our grief with those closest to us because of embarrassment or shame."

A marital relationship is inevit-

Miss Schreiber is an award-winning writer on psychiatry; Herman, the Executive Secretary of the National Association of Private Psychiatric Hospitals.

ably affected. Parents may displace onto their retarded child their dissatisfactions with each other.

When one couple quarreled about what kind of care their son needed, the quarrel had less to do with the child himself than with the resentment the parents felt toward each other. Long before the child was born, the wife felt that the husband, a school teacher, should go into business. Now she reminded him, "We'd have more money to care for our son if only you had listened to me!"

Parents blame each other

In these families, references that are casual in other households, about whether Johnny is more like mother or father and from what side of the family he "got" what trait, assume ominous importance. When Johnny is retarded, the charge that he inherited that retardation not from *me,* but from *you,* triggers a devastating quarrel. That only a fraction of all mental retardation is of hereditary origin has nothing to do with the ugly battle that rages.

A mother can become so involved in caring for the child who is "different" that she neglects her husband both directly and indirectly.

A haunting fear is whether another child will be born retarded, too. When, for instance, one couple consulted their pediatrician, he advised them against having a second child. However, they talked to another doctor, and he encouraged them to go ahead. They did. "I was terrified," she said, "of having another retarded child." In the sixth month of pregnancy she contracted mumps and, "nearly went crazy." The new baby, however, was perfectly normal.

Finances also become a sore point in the family of a retarded child. "Parents," said Mrs. Max A. Murray, president, Virginia Association of Retarded Children, "who have difficulty in accepting the diagnosis of retardation will often spend sizeable sums (regardless of their economic status) going from one doctor to another, from one clinic to another, from one treatment center or training program to another until finally not only their financial situation has become critical, but their health and general efficiency have been irreparably damaged." Their relationship also suffers. *He* blames her for spending the money; *she* blames him.

Parents with retarded boys are more often adversely affected in their marriages than are parents with retarded girls, according to Bernard Farber of the University of Illinois. Why this should be so is not known.

Brothers and sisters of the retarded child have varying reactions. Some develop psychosomatic complaints because they unconsciously feel they can divert their parents' attention from the retarded child only by being ill. Others assume a greater maturity because of their responsibility for the care of the retarded child or because his existence has given them a greater sense of

Brothers and sisters of retarded children experience emotions from guilt and irritation to total acceptance.

poignancy about life.

Normal rivalry may assume a new guise under special circumstances. The normal child may fear that his hostile feelings about a new baby have led to the baby's retardation. Irrational though this guilt is, it remains a very common phenomenon among young children who are confronted with the fact that little brother or sister is not like everybody else. It is also difficult for the young child to understand why mother makes fewer demands on the retarded brother or sister than on the normal one, does things for him that she does not do for the others and gives him little privileges which they are denied.

As the normal child gets older, he may find it difficult to explain the retarded brother or sister to friends. He may even feel that his chances are curtailed. But this is not always the case. For 200 people between the ages of 8 and 36, with one or more mentally retarded brothers or sisters, interviewed by a University of Houston researcher, believe that mental retardation throws fewer stumbling blocks into family life than would blindness or deafness. Two-thirds of the group declared that being related to a retarded sibling had never caused them any embarrassment, hampered family activities or made them hesitant about inviting friends home. None of the girls felt that having a retardate in the family would interfere with their own chances of dating or marriage. Eight percent of the boys, however, thought it might.

A youth panel conducted by the Baltimore Association for Retarded Children on "What It Feels Like to Have a Retarded Brother or Sister," revealed, however, irritations of normal siblings.

"My pet peeve," said a girl, "is that my sister (retarded) is overly affectionate with me. She is always wanting to hug and kiss me. One day she grabbed a little too hard and hurt my jaw."

"We don't get to do a lot of things that some of my friends do," one boy complained. "Some of my friends get to go across the country and things like that. This is the only thing I don't like about my retarded brother, because I want to take trips, but we can't get out of the house because of him."

Some gain insight

Others take a positive approach. "I believe," one boy said, "that having a mentally retarded brother has been an asset instead of a handicap. It has given me a different insight into the various people I meet. Every individual is different."

This boy's point of view is reaffirmed by Meyer Schreiber and Mary Feeley in a study entitled, 'A Guided Group Experience—Siblings

of the Retarded." "In some families," these investigators noted, "where the parents have dealt with the situation constructively, such young people have developed greater maturity, tolerance, patience and responsibility than is common among children their age."

Whether asset or liability, the fact is that the retarded brother or sister has a marked effect on the attitudes and goals of the normal children in the family. Bernard Farber, who conducted a study of 83 boys and girls, aged 10 to 16, with a retarded brother or sister at home, reports that boys, in contrast to boys their age in normal households, placed greater emphasis on success in business, devotion to a worthwhile cause, making a contribution to mankind and, strangely enough, learning not to take life too seriously. Brothers of the retarded, however, showed less interest in having close friends, focusing life around marriage and the family, and being a respected community leader.

Sisters of the retarded emphasized the importance of learning to accept hardships, devotion to a worthwhile cause and making a contribution to mankind. They also de-emphasized close friends, marriage and family and business success.

The difference between the brothers and sisters is further accentuated by the University of Illinois' finding that sisters—and not brothers—often develop neurotic traits. This is possibly so because sisters are often called upon to act as parent-substitutes for the retarded child.

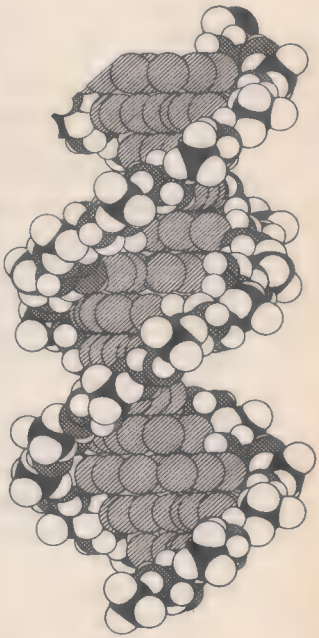
There are also differences in reaction at various times. A point repeatedly made by the children in the studies and by those with whom we talked is that it is harder to cope with the retarded brother or sister when one is an adolescent than at any other time. As one boy put it, "As you go into adolescence, you will reject the retarded child until you mature again!"

Parents determine reaction

The way the brother or sister reacts to the retarded child depends very largely on how the parents handle the retardation. Mrs. William Gorham, the wife of the Assistant Director of Program Planning at Health, Education and Welfare, who has a retarded daughter, said she and her husband try to accept the child for what she is and try to keep her from influencing the lives of the other children.

As Mrs. Gorham told us, "We have accepted our retarded little girl's difference as a normal part of our family life."

An apparent paliative, too, for both the parents and the siblings of the retarded is to join a group that brings them in touch with others in similar positions. "When you are at home or at school, you meet only children with normal brothers and sisters," one girl told us. "But when you join a group of Brothers and Sisters of the Retarded, you frankly discuss problems with each other and you know you are not alone."



A sculptured painting (above) designed to show man's genetic development was created in 1935, and seems to have predicted the structure of DNA (right), not discovered until 1953.

Science follows art

A painting created in 1935 to express mankind's genetic development seems to have predicted the shape of DNA, the fundamental genetic material, almost 20 years before its structure was revealed in 1953 (See page 88). The coincidence was striking enough to induce *The Polytechnic Institute of Brooklyn* to put the painting on display along with a number of scientific models of DNA structure.

The painting, "Genesis—Male and Female," by Abraham Joel Tobias, was one of a large group of "shaped canvases" or non-rectangular paintings first introduced to the art world at Delphic Studios in New York City on Nov. 11, 1935.

Prof. Donald F. Othmer of Polytechnic's Chemical Engineering Department has commented: "An artist departing from the standard rectangular shape has an infinity of planar shapes to choose from. The fact that the shape chosen to depict the shape of the genetic idea bears a strong resemblance to the structure of the genetic material DNA, worked out by scientists 18 years later, is extremely suggestive perhaps of the intuitive relationship between science and art. The two cultures are perhaps closer than we think."

The "shaped canvas" show of 1935 also anticipated some current trends in the art world. The concept of non-rectangular canvases has reemerged recently in art circles and some critics have characterized them as "new."

U.S. is splitting up

According to a theory advanced by Dr. Kenneth L. Cook, head of the *University of Utah* Department of Geophysics, the U.S. may eventually be split into two continents separated by the Gulf of California.

After years of studying earthquake activity at the base of Utah's Wasatch Mountains, Dr. Cook concluded that the Wasatch Fault is part of the World Rift System. The theory of the World Rift System is gaining international popularity among geophysicists and geologists.

Under the rift theory, geophysicists claim the earth's crust is constantly changing as the internal forces slowly pull vast segments apart. They say these changes are associated with a single system of rifts or cracks, the two primary ones bisecting the Atlantic and Pacific Oceans.

"It will not, of course, happen in our lifetime, nor will our great, great, grandchildren see it, but many millions of years hence, a rift valley will continue to develop across Utah, Arizona, Southern Idaho and Wyoming," Dr. Cook said. "Eventually it will fill with water and be similar to the Red Sea that separates Africa and Arabia. This assumes, of course, that the future pattern of the earth's internal forces continues as it exists today and in the recent past."

Dr. Cook believes there is a flow of upwelling, semi-plastic rock deep within the earth which is slowly forcing the continent apart. He likens the rift across Utah to one in the mid-Atlantic and another in Africa, near Lake Tanganyika.

Evidence is "almost compelling," he added, that South America and Africa were once one large earth mass, but over millions of years the

huge continent cracked and has since been slowly drifting apart. The same thing, he said, is happening in western North America.

Hunting the quark

Studies of cosmic rays have led a group of scientists to the conclusion that the quark is so rare that it may not exist at all. Prof. L. W. Jones of the *University of Michigan,* and other American high-energy physicists, have been hunting for a more elementary particle than the atom and its components —a particle which *California Institute* of *Technology* physicist Murray Gell-Mann has dubbed the quark.

Prof. Jones and his colleagues didn't find any quarks, but he believes they may have moved closer to an understanding of how to find them—that is if they exist at all.

The elusive particle has been hunted with giant particle accelerators and among the naturally occuring high-energy particles in cosmic rays. Prof. Jones, however, employed a new technique on a Colorado mountain top.

"This experiment made a different set of assumptions about the nature of the quark than the previously published searches, and was run continually for a period of several months," says Prof. Jones.

"Although no firm evidence for the quark's existence was gained, physicists can now say that if quarks exist at all they must either be very rare indeed or have a very unusual combination of properties."

The known particles which are important to high-energy physics include not only the familiar proton, neutron and electron, but also a large number of mesons and strange particles which decay radioactively into the familiar particles in less than a millionth of a second.

"The significance of the quark theory," Prof. Jones says, "is that it suggests that these numerous particles are in turn made up of a few more fundamental constituents, quarks, in a manner similar to that in which all atoms of the elements are made of only protons, neutrons and electrons."

In Prof. Jones' experiment, the products of energetic cosmic ray interactions high in the atmosphere were studied in a laboratory at Echo Lake, Colo., 10,000 feet above sea level.

The characteristic property sought was the high mass of quarks. Prof. Jones studied 300,000 energetic cosmic ray showers. "Only one candidate for a quark was detected, and even then there was an eight percent chance that this particle was an ordinary proton."

But the experiment "established that quarks can be no more abundant in cosmic rays than one quark for every billion individual cosmic ray particles if quarks are about 10 times as heavy as a proton," Prof. Jones concluded.

Return of the trumpeter swan

by Edwin Heim

FEW people today have watched the giant swan standing on stubby black legs in shallow water at the edge of a river. Suddenly alerted, he'll stretch a long slender neck to survey the marshes across the mountain valley. Then he'll press the panic button.

Half-running and half-flying, he splashes frantically along the water trying to get his 28-pound body into the air. The ends of his broad powerful wings, stretching eight feet from top to tip, beat hollow tones on the water.

Shortly, he is airborne and headed downriver. In his element now, the old trumpeter gains speed fast. Flying 100 feet above the water, he travels at more than 50 miles an hour.

But even when he is only a white speck in the distant blue sky, his wild deep-toned call can still be heard plainly sounding an alarm to other swans. It was this call, early American settlers said, that sounded "like a trumpeter." And the largest of all the world's waterfowl has carried the name ever since.

The trumpeter is the king of the swans, the largest of all waterfowl. The whistling swan looks much like him, but is smaller and has a high-pitched call. Those white swans drifting lazily on pools in city parks are usually mute swans, the trumpeter's European cousins.

Through the 1800s swans were killed for food as well as for feathers. Only in those wild remote mountain valleys, inhospitable to human settlers, did the trumpeters hang on while men drained, dammed and plowed lands where they once nested. By 1900 they were almost gone. A naturalist, Edward Howe Forbush, claimed in 1912 that, "... its total extinction is now only a matter of years."

Still hoping to rescue the big birds, conservationists went to work on a plan to save them.

To begin with, scientists knew a few of the swans' habits. They knew that the female, which is

A flock of the once almost extinct trumpeter swans such as this is still rare, but with conservationists on their side, the swans are slowly growing in number.

called the "pen," lays six or eight eggs. Her nest is usually built on the top of a muskrat house, in a sort of mutual benefit arrangement.

For 35 days the female incubates the eggs while her stately white mate—called the "cob"—stands nearby, ready to sound his trumpeting alarm at the first appearance of a bobcat, coyote or human. The young swans—they're called cygnets—are a drab gray color.

How serious was the plight of the trumpeter? In 1932, pilot biologists took to the air to find out how many were left. In all of the United States south of Canada, they could find only 69 trumpeters.

The biggest flock of the great swans was in the wild remote Centennial Valley snuggled between two mountain ranges in southwestern Montana. Across the mountains in Yellowstone National Park, a few more trumpeters hid out in the wilderness.

Conservationists across the country spoke up for the swan. Then, in 1935, President Franklin D. Roosevelt signed an order creating the Red Rock Lakes National Wildlife Refuge. The new refuge was one of the great system of national wildlife refuges. It lay in the Centennial Valley and was 15 miles long by five miles wide.

In a few years the wildlife biologists knew that the refuge was helping the swans. Protected from predators and hunters, and offered extra feed in winter, the birds increased.

When Red Rock Lakes had all the swans it could support, wildlife biologists began moving a few surplus trumpeters to areas in which they had once lived. In 1960, they took five cygnets to the Lacreek National Wildlife Refuge in South Dakota. Three years later the Lacreek trumpeters raised four cygnets of their own, the first successful nesting of trumpeter swans east of the Rockies in over 80 years.

The big swans are still rare. But because of the Red Rock Lakes National Wildlife Refuge, there are now 600 or more trumpeters—10 times as many as there were south of Canada in 1932. Another 1,500 live in Canada and Alaska. These are all that remain of the thousands that once wintered as far south as the Gulf of Mexico and east as far as the Atlantic Coast.

U.P.I.

QUIZ

The remarkable world of feathers and flight

by John and Molly Daugherty

SHOPPING for food is a chore, but you don't have to shop every day or pick up one item at a time. In some families, shopping for food turns into a show of togetherness—at least among the birds.

A pair of house wrens may make 600 trips a day for food for its young. In fact, one male wren made over 1,200 trips in about 16 hours, averaging a trip every 47 seconds!

Find out how much you know about birds:

1. One of the fastest flying birds, which has a special adaptation against the wind entering its lungs, is the
   a. Peregrine
   b. Belted kingfisher
   c. Red-winged blackbird
2. One of a few birds that has the gift of ventriloquism is the
   a. Pileated woodpecker
   b. Scarlet tanager
   c. Baltimore oriole
3. A bird that lays its eggs in the nests of other species to be reared by foster parents is the
   a. Bob-white
   b. Ground dove
   c. Cow bird
4. In the higher mountain altitudes in the West, the bird that flies and trots in shallow clear water is the
   a. Brown thrasher
   b. Bank swallow
   c. Dipper

5. **A fast-flying bird which has special mouth glands producing a gluelike saliva is the**
   a. Chimney swift
   b. Ruby-throated hummingbird
   c. Herring gull

6. **Birds in flight remind you of different types of aircraft. A bird with the style of a helicopter is the**
   a. Gull
   b. Hummingbird
   c. Falcon

7. **A bird that starts to incubate its first egg without waiting till all the eggs are laid is the**
   a. Snowy owl
   b. California quail
   c. Cardinal

8. **The bird which hangs its kill on a spine to eat at leisure is the**
   a. Barn swallow
   b. Red Crossbill
   c. Shrike

9. **A large American bird of the heron family whose love notes sound like a pump or a stake being driven in the ground is the**
   a. Bittern
   b. Cedar waxwing
   c. Flamingo

10. **Mockingbirds are great mimics of other birds. They are so expert that you need electronic analysis to detect a difference. Generally the maximum number of bird songs wild mockingbirds mimic is about**
   a. 11
   b. 32
   c. 39

Answers:

1 - a Peregrine (also known as falcon or duck hawk). It cruises about 40 to 60 miles an hour, but when it dives, its estimated speed is 200 miles an hour. The lungs of the peregrine are protected from the force of the wind by a series of baffles in its nostrils.

2 - b Scarlet tanager. This gift of ventriloquy makes the tanager hard to locate when hidden. Catbirds are also ventriloquists.

3 - c Cow bird. It lays just one egg in the nest of each other bird it exploits. The owner of the nest incubates the cow bird's egg with her own and usually takes care of the offspring. As many as 90 different species of birds have been subjected to this imposition.

4 - c Dipper (also called the water ouzel). The dipper can stay under water for about 30 seconds before coming up for air. In that time it may have walked or flown about 20 feet. The dipper is an aquatic perching bird. When it goes under water, scalelike flaps close over its nostrils. Its name comes from its habit of rapidly bobbing up and down more than 40 times a minute.

5 - a Chimney swift. It builds its nest in old unused chimneys or hollow trees. The gluelike saliva is used to cement one twig at a time to the vertical walls. To complete the nest requires as long as 18 days.

6 - b Hummingbird. You are most apt to see the ruby-throated hummingbird hovering before a flower motionlessly. Yet in direct flight it may attain speeds up to 60 m.p.h.

Gulls are like sail planes, and falcons are similar to dive bombers and pursuit planes.

7 - a Snowy owl. This owl is a visitor to the United States from the frozen North. It flies north to the arctic tundra to nest as early as the

first of June. Time is vital in the short summer. The snowy owl hastens to incubate the first egg immediately so that the first young may be almost ready to fly by the time the last egg hatches.

8 - c Shrikes (often called the butcher bird). Two species are found in North America—the northern and the loggerhead. When the shrike kills a smaller bird or mouse with its beak, it hangs it on some natural hook or spine—even on barbed wire fences as a butcher hangs up meat. The kill is guarded until eaten.

9 - a Bittern. This bird goes by different local names such as barrel-maker, dunk-a-do or Indian hen. The sound is produced by the bittern's gulping air successively five or six times. This causes a swelling and contortion of the neck, followed by an explosive eruption of air. The boom is loud and is followed by a second sound much like that of a stake's being driven.

10 - c Thirty-nine. In Cambridge, Mass., a wild mockingbird was heard to give the song of 39 other species. A California ornithologist, however, recognized similarities in a captive bird to 58 other species. The mockingbird imitates other sounds, too, such as a squeaky gate, frog, cricket or whistle.

Score yourself:

9 - 10 right You must be a bird watcher.

4 - 8 right Here's where most birds of a feather flocked together!

0 - 3 right You took a swan dive.

Each month Dr. Isaac Asimov chooses one of the questions you send in to answer. He does not make the job easy on himself, for in past months he has written about such things as relativity, parity and the basic nature of light. Following Dr. Asimov's answer are the answers to some of your other questions written by regular members of the Science Digest staff.

Why ice floats

Why does water expand and float when it freezes?

We might ask first: Why is a solid solid? And why is a liquid liquid?

There is a certain attraction between the molecules of a substance that can hold them firmly together in some fixed position. It is hard to pull them apart and the substance is therefore solid.

The molecules contain energy of motion, however, and they jitter about their fixed position. As the temperature goes up, the molecules gain more and more energy, and jitter about more violently. Finally, they gain so much energy that the attraction of other molecules can no longer hold them. They break the grip and move off on their own, slipping and sliding about the other molecules. The solid has then melted; it has become a liquid.

Most solids are crystalline. That is, not only do the molecules remain fixed in place, but they are fixed in regular positions, in ranks and files. This regularity is broken up when the molecules gain enough energy to break away, and the solid melts.

Usually, the regular placing of the molecules in a crystalline solid is in a kind of close order. The molecules are crammed together with little space between them. Once the substance melts, though, the molecules, in sliding past each other, jostle and push one another. The general effect of the pushing is to force all the molecules a bit farther apart. The substance expands and its density decreases. In general, the liquids are less dense than solids.

Putting it another way, solids expand when they melt and liquids contract when they freeze.

A lot, though, depends on just how the molecules are placed in the

solid form. In ice, for instance, the water molecules are arranged in an unusually loose formation. The molecules are in a three-dimensional pattern that actually leaves "holes."

As the temperature rises, the molecules break loose and begin to move about independently, with the usual jostling and pushing. This would move them apart, except that it also moves them into the holes. By filling the holes, the liquid water takes up less room than the solid ice, despite the molecular jostling. When 1 cubic foot of ice melts, only 0.9 cubic feet of water is formed.

Because ice is less dense than water, it floats on water. A cubic foot of ice sinks in water until 0.9 cubic feet are below the water surface. This displaces 0.9 cubic feet of liquid water, which weighs as much as the entire cubic foot of ice. The ice is now buoyed up by the water and the final 0.1 cubic feet remains above the water level. This is true of ice generally. Any piece of ice will float on water with about one-tenth of itself above the water surface and nine-tenths of it below.

This is very fortunate for life generally. As things are, any ice that forms stays on top of a body of water. It insulates the lower depths, and cuts down the amount of heat escaping from below. As a result, the deeper water usually does not freeze even in very cold weather. Then, too, the floating ice receives the full effect of the sun in warmer weather and quickly melts.

If ice were denser than water, it would sink to the bottom as it was formed and more water would be exposed, to freeze in its turn. What's more, ice at the bottom of the body of water would get no chance to pick up the sun's warmth and melt. If ice were denser than water, our planet's water supply would be almost all frozen, even though the earth were no farther from the sun than it is now.

—Isaac Asimov

Why is the ocean salty?

It has been estimated that the oceans contain as much as 50 quadrillion tons (50 million billion tons) of dissolved solids. If all this salt could be removed and spread evenly over the earth's land surface it would form a layer more than 500 feet thick—about the height of a 40-story building.

Primeval seas must have been only slightly salty. But ever since the first rains descended upon the young earth hundreds of millions of years ago, water has run over the land, wearing away rocks, carrying their minerals to the seas, and the ocean has become saltier. It is estimated that the rivers and streams flowing from the United States alone discharge 225 million tons of dissolved solids and 513 million tons of sediment annually to the sea.

Throughout the world, rivers carry an estimated four billion tons of

dissolved salts to the ocean annually. About the same tonnage of salt from the ocean water probably is precipitated on the ocean bottom or otherwise extracted from the water. Thus, yearly gains may offset yearly losses, and the oceans today probably have a balanced salt input and outgo.

When one cubic foot of sea water evaporates, it yields about 2.2 pounds of salt, but one cubic foot of fresh water from Lake Michigan contains only 0.01 pound of salt, or about one-sixth of an ounce. Thus, sea water is 220 times saltier than fresh lake water.

Sea water has been defined as a weak solution of almost everything. Ocean water is indeed a complex solution of mineral salts and of decayed biologic matter that results from the teeming life in the seas. Most of the ocean's salts were derived from the breaking up of the cooled igneous rocks of the earth's crust by weathering and erosion, the wearing down of mountains, and the dissolving action of rains and streams which transported their mineral washings to the sea. Some of the ocean's salts have been dissolved from rocks and sediments below its floor. Other sources of salts include the solid and gaseous materials that escaped from the earth's crust through volcanic vents, or which originated in the atmosphere. These processes and events required countless ages of time in the past and even now continue.—*From the Geological Survey of the U. S. Department of the Interior.*

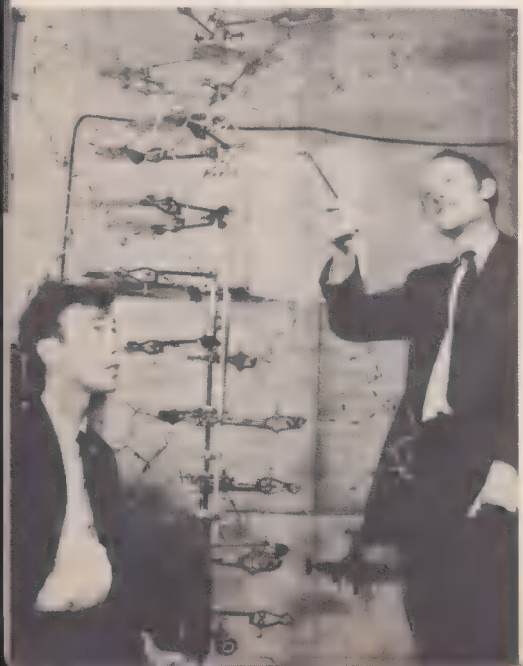
The shape of life to come

The Double Helix. James D. Watson. Athenium. ($5.95).

Probably everyone who reads it will enjoy this book—except some of the principal characters in it. In fact, Harvard University, where the author today is professor of biochemistry and molecular biology, refused to publish it when anguished howls of pen-pricked victims wafted across the Atlantic. Luckily, commercial publishers are not so circumspect about hallowed halls and their inhabitants.

Between 1951 and 1953, four scientists—Francis H. C. Crick and the author (an American) at Cavendish Laboratory in Cambridge, and Maurice H. F. Wilkins with Rosalind Franklin at Kings College, London—were hard at work trying to unveil the secret of how Deoxyribonucleic acid (DNA), the fundamental molecule that carries the hereditary information for all life, is put together. Spurred by the threat that formidable Nobel laureate, Linus Pauling—pursuing the same goal on this side of the ocean —would solve the riddle first, the independent British teams found themselves torn between secrecy and collaboration. Thus, the stage is set for a true tale of suspenseful science adventure.

Watson and Crick stand in front of their double helix, the DNA molecule model.



But it isn't the suspense that will place this volume beside the classics. Watson was 25 when he, Crick and the Kings group won the race that brought three of them, (Miss Franklin died in 1958), the Nobel prize nine years later. Watson's youthful arrogance provided a highly critical eye. Writing today, he faithfully records the view from the mind of the precocious young PhD he was when it all started.

The result is a brashly frank look behind the scenes of high level science; colleagues are appraised as they impressed him; closet doors are flung wide and skeletons picked over. "I have never seen Francis Crick in a modest mood," he says of his partner, for starters, and

wraps him up with: ". . . most people thought he talked too much."

The slithery political game of wangling fellowship grants is graphically exemplified (he was very nearly chopped off by a new director back home). Tricks of the trade are candidly revealed. No one moves in on another scientist's territory—unless he can do it defty. If a man makes a blooper, he may be discredited by his colleagues. There is little mercy in the cluttered labs of theory.

Wealthy patrons ply their gratuitous ploys as they did in Victorian times for the literati; there's a spattering of wine-tasting, riding to the hounds and girls.

In fact, you learn that scientists are people. In the end, the search is for truth. And behind the cruelty of the test tube jungle lies a unique warmth and comraderie. You find that Dr. Watson has a deep understanding and abiding respect even for those he has painstakingly insulted.

Amazingly, as Crick and Watson build their helical model of DNA, you discover that you don't have to follow the detailed chemistry behind the critical A-T and G-C base pairs. The concept is always clear. You know as surely as the author why the DNA molecule *had* to be a double helix.

—RFD

Other new books of interest

The Ghost in the Machine. Arthur Koestler. MacMillan. ($6.95). Man is mad, or so says Arthur Koestler, a well-known author ("Darkness at Noon") and philosopher. He says it is possibly because of an error that occurred in the brain's evolution and brought about two incompatible forces in man, creativity and pathology. This he calls schizophysiology, and he says it is inherent in all men. This paranoid streak which threatens his very existence is man's most serious predicament, he says.

The Transplanted Heart. Peter Hawthorne. Rand McNally.($4.95). Although this book sometimes seems a bit melodramatic in its portrayal of the first human heart transplant, one must keep in mind that the event itself was more dramatic than most pieces of fiction. The activities that preceded the operation and the lives of the medical team involved, headed by Dr. Christiaan Barnard, took on a dramatic overtone, because they all centered around an unprecedented operation that could, and will, affect medical history. It could hardly help but be interesting because of the subject.

Modern Motherhood. H.M.I. Liley, M.D., with Beth Day. Random House. ($4.95). This book for the mother-to-be (and father, of course), while offering a basic guide

to pregnancy, childbirth and the first six months of childhood, goes one step further. It deals with the relatively new study of the unborn, fetology.

Harvest of the Sea. John Bardach. Harper & Row. ($6.95). Oceanography has only recently come into existence as a modern science, but its followers have already uncovered a wealth of knowledge about the ocean depths. Here John Bardach discusses all phases of sea study—past, present and, most of all, future—the potential of the oceans as source of industry, food, power and maybe even living space.

The Edge of Space. Richard A. Craig. Doubleday. ($8.95). The edge of space to which the title refers is six miles up. The conditions existing in the upper atmosphere are vastly different from those of the troposphere, the atmosphere directly above the earth's surface. The author, a meteorologist, reviews the studies that have thus far been made on the upper atmosphere, how research is being done and how important this "edge of space" is.

Mathematical Quickies. Charles W. Trigg. McGraw-Hill. ($7.95). For the math enthusiast, here are nearly 300 "challenge problems" and their corresponding "quickie solutions." But there's more than just the quickie solution. A challenge to find solutions "more elegant" than the ones offered is given to the inquisitive reader.

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Old wives' tale

The last thing that *Science Digest* would want to do is perpetuate an old wives' tale. In the article, "Victory over epilepsy," (Nov. '67), point five on page 30 is doing just this. The tongue cannot be swallowed.

What I think Andrew Hamilton is trying to say is: Be sure that the tongue doesn't relax and block air passage. This can be accomplished by putting the patient on his abdomen with his head on the side or placing the patient on his side.

Mrs. Arnold J. Gorneau
Haverford, Pa.

You are correct. Our author used the popular, but misleading expression to describe what happens when the tongue blocks the air passage.
—Ed.

Battle of the sexes

In reference to "Spinsters are smarter," (January '68), Dr. Jessie Bernard states that among the unmarried, women are "the cream of the crop," while bachelors are "the bottom of the heap." Her conclusion comes from the fact that unmarried men have less formal education, are less likely to be professionals and earn less income than their female counterparts. Wouldn't it be more realistic to say that among the unmarried, women on the average are more educated and tend to hold better jobs?

Most important, what right has Dr. Bernard—or any other person—got to refer to people with little education by the humiliating, degrading label, "the bottom of the heap." Among the well-educated men and women I know, none refers to himself or herself by the arrogant title, "the cream of the crop."

What is significant about Dr. Bernard's study is not so much what it reveals about single men vs. single women, but what it reveals about her attitude toward the men she claims to have studied objectively.

Robert V. Zupkis
Harvard University

Extinction theory questioned

I enjoy *Science Digest* very much and find it most interesting and informative, but I must take exception to the answer given in the "explain" column (February '68) regarding "the extinctions." I find Dr. Paul S. Martin's theory quite untenable. In the first place, man did not bring fire to the new world. It already existed from natural causes such as lightning. Prairie and forest fires were no doubt a hazard to the animals long before man arrived. Furthermore, many of the animals appear to have died on flood plains where their remains were buried.

More important is the "primitive" hunter's attitude toward animals. Whether you examine the cultures of the Amerind (American Indian), the Aborigine of Australia or the

paleolithic man of Europe, two factors stand out. They have rituals to assure the increase of the animals upon which their livelihood depends, and they kill only what they need. The Amerinds of the American West hunted the bison, which numbered in the millions, with bow and arrow, and fought the white man who wantonly slaughtered the beast for tongue and hide almost to extinction. It seems most improbable that peoples able to kill animals in Europe and Asia with stone ax or bow and arrow would lose that skill on their way over the Bering Strait and suddenly be forced to drive herds of animals off convenient cliffs when they needed meat—particularly when weapons such as the folsom points have been found with, and in, mammoth bones.

I would also question the statement that large mammals, or mammals of any kind (excluding the rat), are remarkably tolerant of different types of environments. All of the herbiverous animals are dependent upon a very particular type of vegetation and occur only where it is available. Vegetation is controlled by climate. There is no reason to suppose that they were less selective in the past.

For a full discussion of climatic changes, read "Earth's Shifting Crust" by Charles H. Hapgood, and for a detailed analysis of the extinctions, particularly of the mammoth, Ivan T. Sanderson's "The Dynasty of Abu."

ELIZABETH WATSON
Monterey, Calif.

Man brought fire as a useful tool to the western world, which was the meaning implied. Regarding the buffalo, huge piles of their bones beneath cliffs near Amerind settlements attest to the mass killing techniques—as do oral history and lore of the Indians themselves. Evidence of mammalian migration to areas where adaptation was essential to survival is all around us, with man the prime example. The black bear, too, ranges from Mexico to Alaska (See Mammal Guide, by Ralph Palmer).—Ed.

Water witching "proved"

In your January issue, you had an article, "Psychologists examine the 'secrets' of water witching," that stated water witching is magic and a form of irrational behavior. You further charged those who practice it with consciously or unconsciously

perpetrating a fraud. I am not a water witch. However, quite some time ago when my parents were having a well drilled, at some point in the proceedings a forked branch was tried. I don't recall if it found the water for the well or not. There were claims that over certain areas it was being pulled down. Requiring further proof, as I thought it was being faked, I tried it myself. Believe me, it quite noticeably and consistently did indeed pull down in my hands.

I have no personal interest in water witching, dowsing or whatever you want to call it, but it appears once again, as in your UFO articles, you have misjudged a subject out of your own ignorance of it, thereby badly misleading your readers. To quote from this article, "Almost every major scientific boner—and there have been many—can be traced to a zealous desire to see the world as we think it should be rather than as it actually is." Would this practice really have survived for over 7,000 years if the results were negative and unproductive?

A1C Richard T. Lee
APO Seattle

The known history of divining is 500 years old, not 7,000. The article in question points out that one of the fallacious arguments used by proponents of dowsing is: how can it be spurious when it has been a custom for so long? It's a non sequitur.—Ed.

A most remarkable beast

Keystone

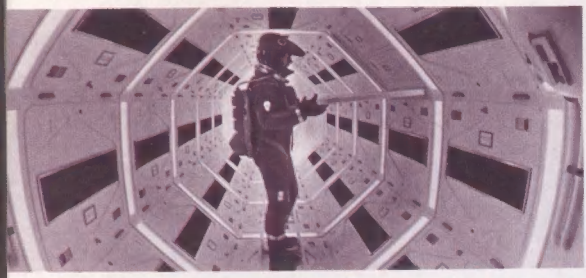
CONSIDER the giraffe. It is a most marvelously adapted creature. Everyone knows of its enormous neck, which makes it the tallest land animal. But the neck serves mainly to get the head up to the leaves on the trees, which almost entirely make up the giraffe's diet. The giraffe's tongue is long, strong and flexible, capable of being extended up to 18 inches. The creature uses it to help pluck leaves from trees. Another aid is the remarkably mobile and sensitive lips, which can grasp an object with the strength and agility of a hand. Giraffes feed by taking the branches in their mouths and tearing the leaves off by pulling their heads away.

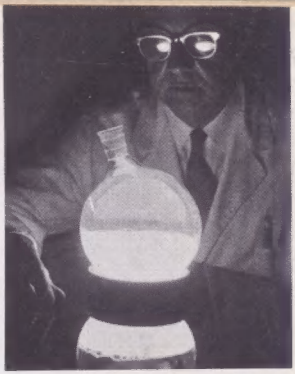
All the giraffe's senses are extremely acute. It probably has the keenest sight of any African big game animal, and its height gives it the greatest range of vision of any terrestrial creature.

Then there are the horns. It has two or four of them plus a knob between its eyes, which is why some refer to the giraffe as five horned.

All-in-all a most remarkable beast.

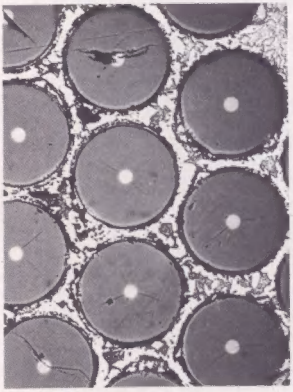
In this issue . . .



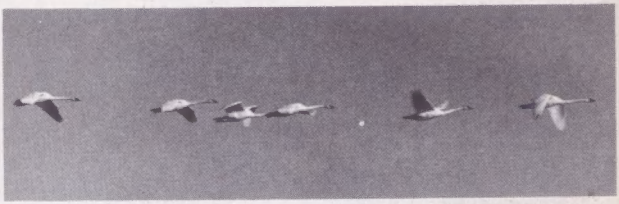


The movie 2001 is the nearest thing to a time machine we have. The director shunned trick photography. For a backstage look at how they made those shots see page 34.

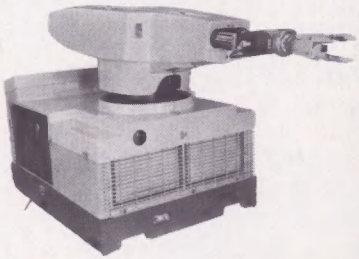
Some simple creatures can do something no warm-blooded creature can: produce their own light. For years scientists have been trying to discover how they do it. Now this mystery seems closer than ever to a solution. The story is on page 63.



If it had not been for the intervention of conservationists, it would no longer be possible to take a picture like the one below. Page 80.

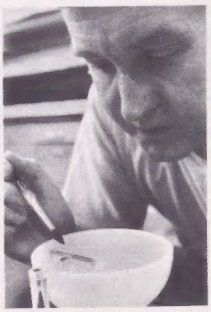


This is a highly magnified closeup of one of the strongest materials in the world, boron filaments. Filaments like these are part of a brand new technology which may revolutionize just about everything. A complete rundown on the technology behind these new materials and their significance to you in this new Age of Fibers begins on page 46.



New man on the Ford production line is Unimate, a robot with a magnetic memory and hydraulically operated muscles. See page 56.

The trip of the Alpha Helix up the Amazon was a scientific expedition and an adventure. Along the way the voyagers met and studied an enormous variety of odd creatures. The story begins on page 22.



Down in Antarctica they're drilling through frozen history, and bringing up 30,000 year old ice. See page 16.

Dr. James H. McConnell touched off the hottest scientific debate of the decade when he began feeding trained flatworms to untrained flatworms. See page 7 for the controversy.